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Selected Set-Construction Techniques

By HERBERT MEYER

Motion-picture production on major studio lots has access to extensive fabricating facilities and know-how for the creation of sets, props and special effects. An attempt is made to aid those engaged in the production of commercial and educational motion pictures with their respective problems by supplying information regarding materials and processes selected to suit lower budgets, smaller facilities and lesser technical skills.

MOTION PICTURES for nontheatrical showing have advanced in technological scope from modest beginnings to where some are being produced on budgets fully comparable with those of Studio A-productions for theatrical release. Between such top creations and the simplest types of product ranges the present bulk of pictures made for the purpose of visually telling a story or to relate a message effectively, interestingly, but still with emphasis on reasonable economy.

The techniques described in this paper have been selected primarily to assist producers of nontheatrical films who plan on installing limited fabrication facilities. This will permit them to enhance sets, production values and mechanical and chemical effects without too great a financial outlay.

While it is believed that in many instances structural units and props can be made and supplied economically and reasonably fast by commercial fabricators, it is recognized that conditions imposed by the particular nature of motion-picture production make this quite often impossible. This causes the producer to think of making himself at least partially independent by having fabricating facilities and know-how of his own.

The term "set construction" as used in the title of this paper refers to studio activities[1] which include the fabricating of set structural units and props, as well as techniques of producing special effects. Selection of materials and fabricating methods is often not simple from an economic standpoint. A careful calculation of relative overall cost may bring to light unexpected advantages in the use of high-priced materials. A typical example is plastics as compared to plaster casts. While the plastic as a material is usually much higher in price per pound than gypsum plaster, the lighter weight and the greater strength of the plastic may offer advantages which, when balanced against high weight and breakability of plaster cast, give the plastic a decided economic advantage.

Fabrication of set structures and props is to a large extent an art craft. The individual in charge of this activity is quite important since his ingenuity and practical knowledge can produce continuous savings, improvements and new values.

Initial investment, while not necessarily extravagant, should be adequate. Delays, failures and inferior product quality due to inadequate facilities are not only much more costly in time than the sum saved by skimping on installations, but they create negative attitudes such as disappointment, lack of enthusiasm and loss of interest in quality maintenance.

Fabrication of Structural Units, Statuary and Props

Originals and Models. Objects selected for reproduction are either originals or hand-formed models.

Originals may be art and utility objects of widely different shapes, sizes and materials. They may also be natural objects, such as rock formations, tree trunks, bark, etc., or structural items like brick, stone and other types of walls, tile, shingle and slate roofing, all varying in shape and composition.

Hand-formed *models* may be produced from water clays, plastilene clays, plaster, soap, wax or wood.

Duplication of these items by the general method of casting involves two steps: (a) the making of a negative, which is the cast produced in direct contact with the original or model and which is termed the "female mold;" and (b) the making of a positive, which is the cast produced in contact with the negative mold and which represents the duplicate reproduction of the original or the model. This process, therefore, also incorporates the negative-positive principle upon which photographic reproduction is based.

Molds

Among many materials used for the fabrication of molds, three types are particularly suggested and will be discussed regarding their special merits, limitations and application methods. These are gypsum plaster, glue-gelatin and plasticized polyvinyl chloride (hereafter referred to as "PVC").

Gypsum plaster yields rigid molds and can therefore not be used for work involving pronounced undercuts. Porous and water-sensitive originals or models, particularly wood, have to be carefully lacquer-sealed before being contacted by the plaster slurry. It is recommended to cut the sealer back sufficiently with thinner so that the model readily absorbs the first brush-coat. A second coat is applied after the first one has thoroughly dried. To assure proper release between original or model and plaster mold, a separator or parting agent is applied in addition to the seal-coat. Suggested for this function is floor wax, vaseline or petroleum jelly, the latter diluted under cautious heating with approximately two parts of kerosene.

For the majority of applications stan-

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dard casting plaster[c,e] is satisfactory. For molds from which a large number of castings is requested, Hydrocal,[e] a calcined plaster of greater hardness and strength is recommended, although it is more expensive. The technology of plaster casting is well described in brochures of gypsum-plaster manufacturers[3] and it will, therefore, suffice merely to summarize points of major importance.

(1) Sift plaster evenly into clean water without stirring until wetting of added plaster ceases. The unmixed plaster is then allowed to remain undisturbed from 2 to 4 min. Then stir by hand or better by means of a drill motor with a rubber disk from 2 to 5 min until the slurry attains the consistency of thick cream. At this point the mixture is ready for pouring.

(2) Strength of plaster cast depends upon the plaster-to-water ratio (or consistency) of the fluid mix. For best results (high strength with proper fluidity) stay within the following ratios by weight:

Casting plaster — 100 parts; water—67–80 parts;

Calcined plaster (Hydrocal) — 100 parts; water—30–50 parts.

(3) Retarder for plaster setting: soda; accelerator for plaster setting: ammonium sulfate or sodium chloride (table salt).

(4) Hemp or sisal fiber[b] is most frequently used for reinforcement. It is supplied in bales and must be picked apart to loosen the individual strands. A handful is made into a flat bat, dipped into plaster slurry and incorporated into the cast layer of the mold.

Glue Gelatin. Molds from this material are used for large plaster casts and also where originals and models of delicate, heat-sensitive composition have to be reproduced. The flexible nature of the gelled glue allows its use in making molds from originals or models with deep undercuts.

Higher quality grades of hide glue which are supplied in flake form[c] are best suited for this application. The glue is first pre-soaked for about 10 min in standing cold water until it softens to where it will not break when bent between fingers. The excess water is then poured off and the gelatin heated in a double boiler to a temperature of approximately 160 to 180 F. Only small amounts of water are added, if at all necessary, for thinning. The melt is stirred until it is completely free from lumps.

Before pouring, the surface of the model is first carefully lacquer-sealed. A uniform layer of water-clay, approximately $\frac{3}{4}$ in. thick, is then applied, which in turn is covered with an outer shell coating of plaster, strengthened and thickened with hemp fibers. Boards to serve as handles and braces are tied in also with hemp and plaster at this time. After the plaster shell has set and hardened, the layer of clay is removed and the plaster shellacked and surface-brushed with a release agent. The glue melt is poured into the space left by the clay layer. After the glue has gelled it is treated with a saturated solution of alum in water which is brushed over the glue surface and allowed to dry. This treatment hardens the glue surface and reduces its water sensitivity. Any white material formed upon drying is brushed off. The time for hardening is between two and four hours. A suitable release agent between glue-gelatin and plaster is a mixture of stearin and kerosene which is prepared as follows: melt $\frac{1}{4}$ lb stearic acid shaved to flakes; remove the heat source and add one pint of kerosene with constant stirring until a uniform mixture is obtained.

For re-use the glue mold is cut into $\frac{1}{4}$-in. cubes. If glue is to be stored, it must be dried; otherwise it will mildew. Glue-gelatin is a low-cost re-usable material. However, it is not dimensionably stable and may show considerable shrinkage as it is susceptible to variations in humidity. It must be applied under cool shop conditions, with cold plaster slurries, or it will melt in service.

Plasticized Polyvinyl Chloride (PVC). This relatively new material is now used by all major studios for the fabrication of flexible, long-lasting and dimensionally stable molds. Faulty and worn-out molds can be reclaimed by simply shredding the material through an electric meat grinder.

Since this compound has to be melted and poured at a temperature of from 275 to 350 F it cannot be used for making molds from originals or models composed of heat-sensitive materials. Through application of vacuum, however, it has been found possible to cast this hot melt against plaster and other porous materials resulting in perfect mold surfaces free from pin holes and gas bubbles caused by expanding steam and air.[3] PVC is supplied in form of a rubbery stringy material (Plastiflex,[d] Koroseal FMC[e]). It should be melted in enameled iron, pyrex-glass, vitreous-china or stainless-steel containers. Overheating causes rapid decomposition. Charred parts must be discarded since they will spoil the entire melt. For melting up to five gallons the use of a standard electric roaster (turkey roaster) is suggested. Electric heat lamps, coils or strip heaters are mounted overhead, with height adjustable, to furnish heat radiating down into the melting material. In this manner, the surface of the melting mass is maintained always at the safe maximum temperature and the rate of melting is greatly increased. For making major batches special melters with heating jackets and mechanical stirrers are available. Detailed information pertaining to equipment and preparation of models and outer shells for vacuum application is best obtained from the suppliers of the mold material.[4]

For small-size, flat work (like plaques or rosettes) the model is simply placed over one of the vacuum ports drilled through the marble top of the work table. A sheet-metal collar is placed around the model which is at least $\frac{1}{2}$ in. higher than the highest relief point on the model. The collar is held in place by running a band of water clay around the outside and pressing the clay firmly to the bench top and the collar. The evacuator is now turned on and the hot melt poured over the model until it covers the highest point by at least $\frac{1}{2}$ in. After cooling, the vacuum is turned off and the mold can be removed from the model. For major statuary work, clay spacers and plaster pouring shells have to be employed as described for glue-gelatin molds.

All molds made with flexible, elastic materials (glue-gelatin, PVC) must be backed up by rigid plaster shells when in use for casting to prevent mold distortions.

Fabrication of Articles Using Molds

The previously described molds, of either rigid or flexible type, can be used in various ways to obtain positive reproductions of corresponding originals or models.

It is, of course, possible and quite simple to make duplicate molds of an original mold for the purpose of changing to a mold material which could not be used in direct contact with the original or model. For example, a glue-gelatin mold or a plaster mold can be easily duplicated in PVC material by first making a plaster male cast and from this a duplicate PVC female mold using vacuum. Some of the principal methods which have found use for fabricating staff and props are discussed below.

Plain Casting

Casting Plaster is used to make average-size statuary and can be cast in either plaster or PVC molds. For fabricates expected to be put to great abuse or for small objects such as letters, numerals, flower designs, etc., the use of *Hydrocal* is recommended. Casting is done by simply pouring the creamed plaster slurry into the mold. The parting agent for plaster cast from plaster mold is stearic acid-kerosene. For plaster cast in a PVC mold a release agent is not required.

Phenolic Casting Resins poured in either plaster or PVC molds are useful for making hardware and delicate orna-

[c] Letter superscripts refer to the Materials Sources listing at the end of the paper.

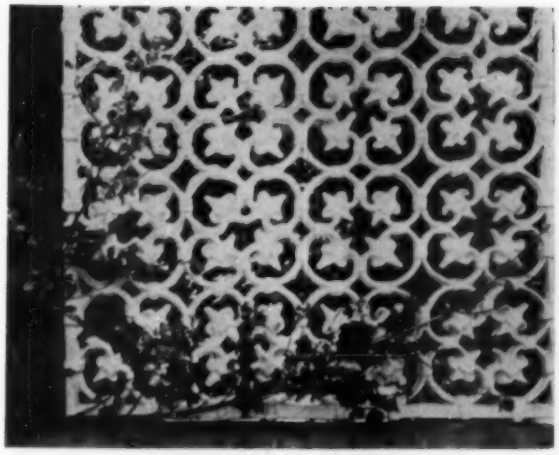

Fig. 1. Phenolic resin cast.

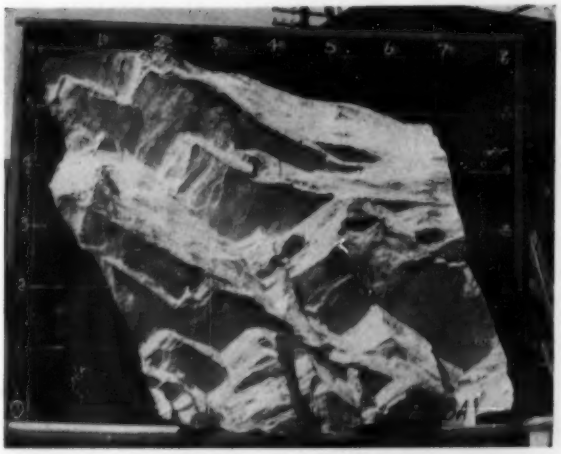

Fig. 2. Rock facing, reinforced plaster cast.

mental grill patterns (Fig. 1). The resin, which is supplied[f] as a liquid, is first mixed with a curing agent or hardener. For ultimate strength the cast resin is cured at 180 F for approximately two hours. This resin is normally supplied as a cream colored, opaque material. Aniline dyes[g] can be mixed in with the liquid resin for color effects.

When using plaster molds, a seal-coat of shellac and two coats of floor wax are suggested. No parting agent is required with PVC molds. The cast articles can be plated or spray-metallized. (See later reference under "Metallizing Effects.")

Wax, such as paraffin, Carnauba and others (Aristo Wax #165)[h] is cast hot in wet plaster molds. It is used for simulating foods on tables or plates, such as meats, fruits, vegetables, etc. It can be easily dyed or pigmented.

Polyester. Plain polyester resin is used in either plaster or PVC molds to cast colorless or tinted transparent props such as vases, statuary, lamp fixtures, etc. The high shrinkage of such resins requires careful formulation and pre-experimentation. Alabaster effects can be obtained by mixing the resin with varying amounts of chalk, calcium carbonate and other fillers. The technique of using polyester resins is discussed in greater detail in a later section.

Castings with Reinforced Materials

In this category is included the large group of structural units and effects, such as brick, stone, textured walls, tile, cobblestone, rocks, adobe, shingle, logs, etc.

Reinforced Plaster. When using *casting plaster*, the same technique is employed as that described for making plaster molds. Reinforcement with hemp or sisal fibers may be incorporated throughout the thickness of the plaster cast (Fig. 2) or the cast may be made in two layers with the first one next to the mold free from fibers. For flat casts, such as wall segments, onion cloth and burlap are also used as reinforcement.

The model for *adobe* simulation is obtained by troweling a thick mud slurry onto a flat surface and exposing it to the sun until it develops the typical cracks (Fig. 3). A flexible PVC mold is then made thereof.

Cobblestone is cast in 3 × 4-ft units from Hydrocal plaster. In making the cobblestone mold, care has to be taken to adjust all reliefs to approximately the same height, since a prominent single protrusion will cause a disturbing straight line pattern when the cast cobblestone units are assembled on the ground.

Sand finish for cast plaster walls is obtained by mixing sand (or sawdust), plaster and pigments with water to a paste and troweling it over the surface. Frequently, umber or other dark pigments are used to reduce the white glare of plaster cast. For sake of uniformity it is recommended that the pigment be mixed with the dry plaster prior to making the slurry.

Ageing effects for walls and rocks are obtained by spotting baking soda or sawdust in the mold prior to pouring the plaster slurry. The soda foams and disintegrates, leaving irregularly shaped small cavities. The sawdust is blown out with compressed air, after the plaster sets.

Fiberglas Reinforced Polyester Resins. The technique of fabricating staff from such materials in either plaster or PVC molds has found considerable application in major studios by now (Figs. 4–6). The fact that the resins employed are 15 to 30 times higher in price per pound compared to gypsum plaster makes it advisable to confine their use to items where light weight and great durability are of primary importance. The method

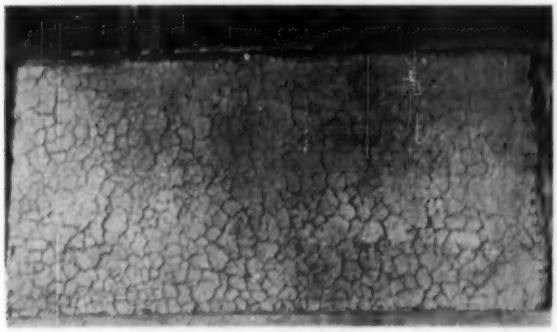

Fig. 3. Model for adobe effect.

Fig. 4. Stone wall unit; reinforced polyester resin cast.

Fig. 5. Tree trunk; reinforced polyester resin cast.

Fig. 6. Sculptured idol; reinforced polyester resin cast.

of fabrication is basically a manual layup technique. The resin is thickened with asbestos powder to a pastelike, nonsagging consistency and is brushed and stippled into the mold with Fiberglas mat, Fiberglas cloth and loose Fiberglas rovings[4] as the reinforcing materials. Addition of catalyst and accelerator to the resin causes it to polymerize, that is, to gel and to set up rigid within a predeterminable time dependent upon amounts and ratios of catalyst-accelerator system, resin temperature and other factors. The catalyst generally used in studio work is Lupersol-DDM (60% solution of methyl ethyl ketone peroxide in dibutylphthalate),[5] the accelerator is cobalt naphthenate.[5] Fabricates made by this system can be cured at room temperature or in sunlight or are end-cured through application of moderate heat to obtain a completely tack-free surface.

The growing field of commercial application for glass-reinforced polyester resins over the last five years has prompted a number of chemical companies to undertake manufacture and supply of such resins.[m] Their printed bulletins[5] and brochures[6] give detailed instructions and suggestions for proper use of their products under various conditions and for many purposes. This includes also information on the use of fillers and extenders and of suitable dyes and pigments.

Sealers and mold release agents for polyester resins recommended from studio experience are: (a) for PVC molds—special Methocel formula or Dow Corning No. 7,[o] and (b) for plaster molds—lacquer sealer, followed by two coats of floor wax.

The special Methocel formula consists of:

Methocel 15 CPS[o] (centipoise/sec) . . 6 oz
N-acetylethanolamine[p] . . . . . ¾ oz
Water . . . . . 1 gal

Heat approximately ½ gal of water to slightly less than boiling temperature and take container with water off heater. Mix in the *N*-acetylethanolamine (liquid). Slowly sift in the Methocel powder under constant stirring to prevent formation of lumps. Stirring is continued until all the Methocel is thoroughly wetted (approximately 10 min.). Add ¾ gal of cold water.

Place container with mixture in refrigerator, stirring the compound briefly at intervals until it reaches approximately room temperature. To obtain a clear solution, the compound is left overnight in the refrigerator. The end product is a slightly syrupy liquid which can be easily brushed into the mold surface and which dries within a reasonably short time. Re-coat the mold with the parting agent between each casting.

Foam-Rubber Fabricates

A series of foam-rubber compounds have been developed for use in motion-picture studios to produce foam-rubber props ranging in weight from several hundred pounds to a fraction of an ounce and in versatility from special effects (such as animated floors, animals, human heads, dummies, rocks, guns, knives, etc.) to special make-up articles (such as noses, eyelashes and other facial features). These compounds can be processed for fabrication without special chemical control, in inexpensive, available equipment and in common plaster molds. The following is a basic foam-rubber formulation composed of ingredients[q] commercially available that will produce a large variety of articles. Colors may be added as required. The quantities shown are for wet, unfoamed material which can be foamed up to 10 times its volume, if desired:

Basic Formula:

C & S No. 5 Latex Foam Base . . . 1 gal
C & S No. 2 Creaming Compound . 336 g
C & S No. 3 Cure Aid . . . . . 24 g
Water of dilution . . . . . 128 g
C & S No. 4 Activator . . . . . 152 g
C & S No. 5 Setting Compound . . 44 g

Recommended Procedure:

(a) Weigh the foam base (No. 5), No. 2, No. 3 and dilution water into a mixing bowl and mix at high speed, until

desired volume is obtained (usually 5 to 6 min). Use for this purpose an egg-beater type of mixer.

(b) Slow down the whip speed and continue to whip for 8 to 10 min. This will break down the large air bubbles formed during the fast whip into more uniform smaller bubbles.

(c) At slow whip speed, add No. 4 Activator and continue to whip for 2 min.

(d) Still at slow whip speed, add No. 5 Setting Compound and whip for 1 min.

(e) Pour immediately and quickly into plaster molds, close molds and allow to stand undisturbed until full gel has occurred before moving the molds. Split molds are used and must be filled as completely as possible since there is always shrinkage. Any jarring of the molds is liable to cause the gel to collapse, leading to voids. Use dry plaster molds, cast as thin as possible.

(f) Place molds in dry air oven and cure at approximately 200 F for 3 to 6 hr, depending upon the size of the article and the thickness of the plaster molds.

(g) For release of the article from plaster molds spray the mold lightly with a mixture of French chalk and alcohol.

Special techniques have been worked out for various studio work and this information can be obtained from the supplier upon request.

Rubber Slip-Casting

This process, regularly employed in studio prop shops, is used for making full-size and miniature dummies, heads, arms, hands, appendages, etc., and to fabricate animal skins and heads for animation. It is also used by the make-up departments for slipover, full-head masks, built-up life masks, and arm and hand sections.

The materials used for this process which are commercially available,[9] are formulated to produce flexible to rigid, hollow articles. The process of fabricating is as follows:

(a) A plaster mold is filled with the liquid rubber compound and allowed to stand until the desired wall thickness is built up on the plaster mold by dehydration of water (time required is normally 5 to 20 min depending upon the wall thickness desired).

(b) The excess rubber compound, still in liquid state, is poured out and saved, as it may be used over again and will keep indefinitely.

(c) The plaster mold, containing the hollow rubber casting, is allowed to dry sufficiently to permit removal of the casting without tearing or deforming. At elevated temperatures of 140 to 200 F 10 min drying should normally be sufficient for small articles, while large objects of greater wall thickness may require 30 to 60 min.

A series of colors available from the supplier may be added to these compounds to achieve almost any shade.

Inasmuch as this slip-casting process is dependent upon the porosity of the master mold for dehydrating and thus depositing a thickness of rubber upon its walls, it is clear that a thoroughly dry mold will build up maximum wall thickness within the shortest time. For the same reason, ordinary casting plaster is usually a better mold material than less porous, harder plasters. The mold should not be sized in any case with gelatin, shellac or waxes, as this would destroy its porosity.

Breakaway Cast

Opaque Dinnerware, Vases, Etc. Articles of this type can be fabricated from plaster, cast in plaster or PVC molds. The cast should be very thin. They can also be cast from stearin or various waxes, to which plaster or French chalk may be added as a filler (10 to 50% by weight). Bottles can be cast in split molds held together by rubber bands. The plaster slurry or the molten wax is slushed around the mold to cover completely the inside walls of the mold, then the excess poured out.

Transparent Bottles, Glasswares and Window Panes. Aside from rosin with its usually objectionable dark color, two synthetic compounds, Santolite MHP[9] and Polystyrene PS-2[9] are presently the best suited materials for these types of props. Both are used as hot melts but differ markedly in certain properties.

Santolite MHP reaches a pourable viscosity at a lower temperature than PS-2 which is desirable where plaster molds are employed. It also maintains fluidity over a wider temperature range which makes it less difficult to cast thin window panes. Finally, it breaks slightly easier and with fragments of duller edges, so that particularly window panes made from Santolite are considered safer breakaway props where these have to be broken by hand or through impact with parts of the human body (Fig. 7). However, Santolite will begin to soften at approximately 100 F and, therefore, articles made with this material exhibit "cold flow" and will sag and become distorted on storage and, particularly, when exposed to the heat radiation of set lighting. Santolite is also more sensitive to heat discoloration during the melting operations.

For fabrication of window panes with Santolite, the resin is heated in a pan or pot to 280 to 300 F whereby local overheating should be avoided. The type of surface upon which the pane is to be cast is critical since the wrong material will cause bubbling. A casting surface of wood will give off air and moisture to form bubbles which would rise through the cast resin material and become trapped within. A metal or marble surface is too cold and the liquid resin would solidify almost immediately, causing cold flow lines. Tempered Masonite boards are a satisfactory compromise. A wooden frame, the size of the desired pane, is made and the side which is to be laid upon the Masonite is covered with cellophane.

The film should be stretched as tightly as possible across the frame and securely tacked. Prior to casting, the cellophane should be heated under an infrared lamp or in an oven to drive out any moisture. This prevents later formation of bubbles at the time of casting and also causes the cellophane to stretch smoothly and wrinkle free across the frame. The heated frame is now placed upon the Masonite and the Santolite melt poured onto the cellophane. The first cast is used to warm the Masonite and release all absorbed moisture. The second casting is the start of production. The Santolite cools rapidly after pouring and the cellophane can be cut from the frame which is then prepared for the next casting. Even with careful procedure, bubbles of minute size will appear on the under-surface. They can be eliminated by flaming with a gas burner or by wiping with methylethyl ketone solvent after the window pane has solidified.

Polystyrene PS-2 offers the principal advantage of yielding castings with high clarity. They are practically colorless and show no tendency toward cold flow in storage or when exposed to the ambient temperatures of lighted sets.

Glassware, bottles, or ornaments made with polystyrene PS-2 resin are fabricated by the following method: The PS-2 resin is heated to 325–360 F and 15% (by weight) of Plasticizer 276–V9[9] is added. The melt is poured into wet plaster split molds, held tightly together with heavy rubber bands and slushed around so that the inner mold surface is completely covered. Only experience by actual trial can establish the amount of resin that should be used in a mold for a desired thickness. To minimize bubbling when the PS-2 hot-melt contacts the plaster wall, a small amount of

Fig. 7. Breakaway window; Santolite MHP resin cast.

Fig. 8. Casting phenolic foam resin into paper lined, wooden mold.

Fig. 9. Breakaway beams, phenolic foam resin cast.

natural rubber latex is first slushed in and allowed to air dry for about 5 min. This also promotes good release of the cast from the plaster mold. In case a mold is used extensively and repeatedly, it is desirable to obtain split-mold parts fabricated of aluminum. After the mold is slushed with the hot melt, the excess, if any, is poured out and the mold is placed in water to cool, with water also running into the mold. If after removal of the cast a frostiness or bubbles are observed, they can be removed by flaming or wiping with acetone solvent.

Breakaway Structural Units, Segments and Specific Props. Breakaway plaster walls are made of a slurry composed of 25% plaster and 75% sawdust (by weight).

Light-weight mortars and cannons are fabricated in plaster molds by compacting ground cork (surplus or waste material from refrigerator insulation) with Weldwood glue[e] as a binder which sets up at room temperature. Suitable pigments can be mixed in.

Foamable Plaster. This material, commercially available under the trade name "Snow Plaster,"[d] is a gypsum plaster compounded with special additives which when the dry material is mixed with water, causes the slurry to foam up. The expanded mass sets to a fragile, lightweight, rigid material used, among other things, to fabricate breakaway walls and sections.

Casting of snow plaster is usually carried out in water-sealed wooden boxes as follows: Seven gallons of water are poured in a 2 × 2 × 2-ft box. Fourteen gallons of snow plaster (measured by volume and not by weight) are added all at once and the mixture quickly stirred. Foaming starts immediately. The box has to be protected against any vibration or jars which would cause the foamed plaster to collapse. The setting time is approximately 30 min. A saw blade is used to remove the cast from the box. Regular plaster is often added (10% to 25%) to the snow plaster prior to making the slurry to modify the breaking strength of the cast. Pigments can also be incorporated with the dry powder. The name "Snow Plaster" reveals that it was originally intended for use as a dress-snow material.

Phenolic Foam Resin. A phenolic resin and certain chemical additives which promote curing and expanding of the resin into lightweight rigid foams has recently become available[e] for studio application and has been successfully used for making rocks, breakaway beams and other props.

A practical formula for the fabrication of lightweight beams is given as follows:

Liquid Phenolic Resin PR-506	100 parts
Foaming Powder PR-506-F	½ part
Foam Promoter PR-FP/50	¼ part
Pigment	1 to 2 parts
Accelerator PR-324	20 parts

The accelerator is a mixture of phosphoric and hydrochloric acid which reacts with the foaming powder to produce hydrogen gas causing the liquid resin to expand and foam. It also reacts as a catalyst promoting the room temperature cure of the liquid to a rigid resin. The foaming powder is atomized aluminum powder. The foam promoter is a nonionic surfactant designed to control the cellular size of the foam and thereby help increase or decrease the foam density.

Density, tensile and compressive strength of the foamed end product can be modified within a wide range by the amount of foaming powder used.

Fabrication of a breakaway beam (Figs. 8 and 9) is conducted by the following method: The foaming powder, dark brown pigments and foam promoter are weighed out and added to the liquid resin which should normally have a temperature of not less than 75 F. The mixture is stirred for approximately 5 min to disperse evenly all additives (use electric hand stirrer). The accelerator is next added with stirring for 1 min. The material is then immediately poured into the mold distributing it evenly over the bottom area. Foaming starts within 1 min and is completed within 5 min, whereupon the mold can be opened and the foam removed.

Ultimate strength is obtained after 24–48 hr at room temperature. This can be accelerated, if desired, by a 3–4 hr post-cure at a temperature of 180 F. The temperature of the liquid phenolic resin at the time of mixing determines the speed with which the foaming and initial setting of the mixture takes place. The lower the temperature the slower the reaction. It is suggested that the liquid phenolic resin be stored at low temperatures (preferably in a refrigerator) to prolong its storage life which for freshly prepared resin at room temperature is approximately 60 days.

The mold (6 in. × 8 in. × 8 ft) used for the beam is made from ordinary wooden boards which are waxed between each casting with paste floor wax and lined with tissue paper to prevent adhesion between resin cast and mold surface. The mold is closed with a hinged wooden lid provided with 8 evenly spaced ½-in. diameter holes for the release of reaction steam and hydrogen gas. The density of the finished beam is about 3.7 lb/cu ft. Almost any type of mold material is acceptable. The process can be performed in open or closed molds. The lining of the mold with paper which will fuse to the resin as it cures will give it an easily paintable exterior surface.

Heat-Forming of Thermoplastic Sheets

Studio prop shops have found increasing use for heat drawing and forming of sheet materials which have become available in great variety of composition, size, thickness and cost. Acrylic (Plexiglas)[e],

cellulosic (Lumarith),[e] polystyrene and related materials (Styron #475,[e] Royalite[e]) among many other products, are by now well introduced for fabrication of plastic bubbles, armor, helmets, and many other prop items that may be opaque, transparent or translucent (Fig. 10). These sheets are thermoplastic, and, therefore, when properly heated, can be formed over a male or female mold by vacuum, compressed air, plunger technique, embossing and stamping. In cooling, the material regains its rigidity and retains all details of shape into which it was molded during the heat-forming operation. Fabricating facilities may range from simple heating over open gas burners and manual molding to huge automatic equipment for deep-draw vacuum-forming.

One studio has installed efficient equipment of moderate cost (which was quickly amortized by savings in time alone), consisting of a vacuum pump, a vacuum "storage" tank, an infrared heating unit and a metal box which holds the mold and supports the plastic sheet (Fig. 11).

The forming of a part is simple and fast. The pump is turned on and the tank evacuated. The male or female mold (which may be of plaster or other material) is placed in the bottom of the box while the plastic sheet is positioned above the mold and clamped tight by means of a metal frame with rubber lining. Next, the movable heat unit is pulled into place directly over the plastic. After a short period of heating (from one to several minutes, depending on the type and thickness of plastic), the sheet softens and the box is evacuated, causing the flaccid sheet to drop and form over the mold. The heat is then removed and after a short cooling period the vacuum is turned off and the part released from the mold by a blast of compressed air. The remaining steps consist of trimming, bonding, painting and decorating.

It is also felt that certain items, ordinarily made of plaster or polyester, could be fabricated more quickly and more economically by such methods and materials. This appears particularly true for stock items of shallow relief design, such as brick and stone wall segments.

Specialty Paints, Coatings and Adhesives

In addition to the great variety of functional and ornamental paints, varnishes and lacquers which are consumed by the motion-picture industry for conventional applications, a substantial number of special formulations have been developed for unique uses of singular interest to set construction. A limited selection of such materials is discussed below because of technical or cost saving considerations.

Peelable Wallpaper Paste. Some time ago it was found that pastes made from water-soluble cellulosic gums, such as methyl cellulose, will adhere wallpaper to lacquer sealed surfaces in such a way that the paper can be peeled off cleanly if removal is required. Adhesives of this type are by now in general use in all studios wherever wallpaper and other type of surfacing materials (including floor tiles and linoleum) are employed in building sets for temporary use. Peelable wallpaper paste for this purpose consists of a 2% water solution of methyl cellulose 4000 CPS[e] (centipoise/sec) which is a liquid of fairly heavy consistency and which can be diluted to proper brushing fluidity by merely adding water.

The paste handles in very similar fashion to wallpaper flour paste. It can be modified with small amounts of glycerine to "stay open" for a longer time, if so desired. Should heavier paper stock give trouble by not properly adhering to certain overly smooth surfaces, the adhesion of the paste can be easily and controllably increased to the desired degree by the addition of a small portion of flour paste. To peel the wallpaper, it is merely necessary to make an incision close to the top or the bottom of the surface to obtain a start from which to initiate the peeling procedure (Figs. 12–14).

Plain butcher paper is glued in a similar way with peel paste to sealed walls and then coated with paint when painted interiors are requested. This method offers a simple way of thoroughly removing painted surface coatings from set walls without damage to the sealed wall surface.

Paints for Underwater Props and Structures. A large quantity of paints based on formulation with chlorinated rubber[e] is being used by the studios with excellent results in painting structures and props of various materials, including plaster cast, which are then used in tanks and pools partly or completely submerged in water.

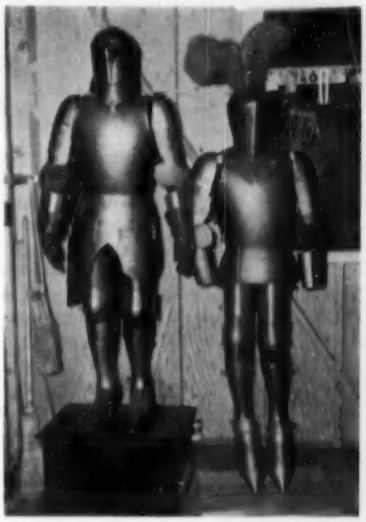

Fig. 10. Armor, vacuum-heat formed from Royalite sheets.

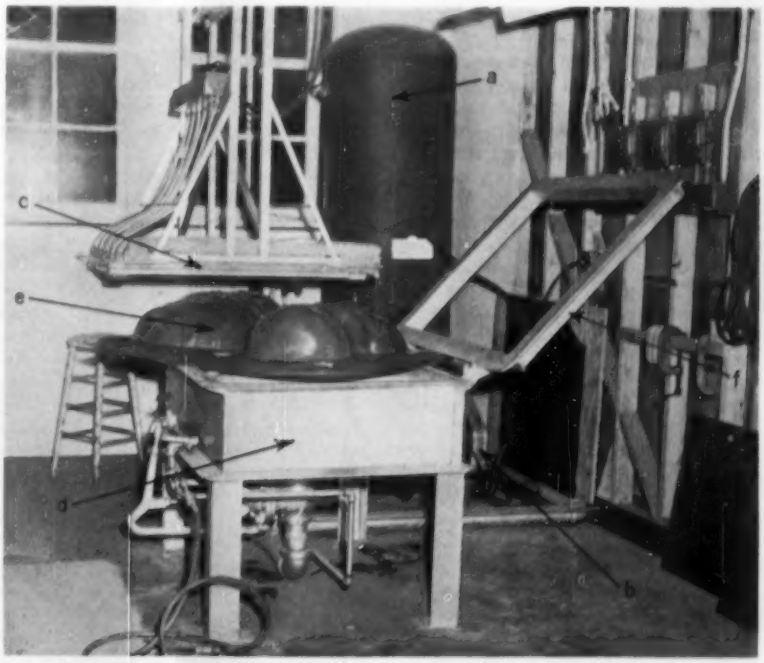

Fig. 11. Vacuum-heat forming installation: (a) vacuum storage tank; (b) vacuum pump; (c) infrared heating unit; (d) metal box holding plaster mold; (e) formed plastic sheet; (f) metal frame.

Fig. 12. Old method of removing wall paper from flats by scraping.

Painting Over Wet ("Hot") Plaster Cast. Quite frequently plaster casts that have not sufficiently dried have to be painted to comply with emergency production schedules. It has been found that paints formulated with polyvinyl acetate latex or formulated from a solvent system with Pliolite S-5 are particularly satisfactory to cope with this difficult problem.[g] Sealing the plaster with a coat of shellac prior to application of the paint coat is recommended.

Metallizing Effects. A recently developed process permits the creation of metallic effects, strikingly simulating gold, brass, copper, bronze and silver. These surface effects can be obtained on props, statuary and any other articles produced of various materials such as wood, plaster, metal or plastic. The process consists of three basic steps. The first one effects a complete sealing of the surface to be metallized with a sealer suitable for the successful execution of the second step. This second operation produces a silver mirror over the sealed surface. The final step consists of a clear or dye lacquer treatment producing the desired metallic tint and protecting the silvered surface against oxidation and damage from handling.

A suitable sealer for the first step is a phenolic varnish commercially available under the trade name "Plastiglaze No. 100."[d] To assure proper sealing, six brush coats are recommended allowing ½-hr drying time between coatings and overnight drying for the last coat.

The compounds and the spray gun necessary to produce the silver-mirror are commercially available including detailed instructions describing all required steps.[e]

The lacquer (trade name "All Purpose Lacquer") and the dye concentrates which have proven to give satisfactory results are also commercially available products.[aa]

The following table lists the approximate volumes of dye concentrates in cubic centimeters which have to be added to one gallon of clear All Purpose Lacquer for bronze, gold and brass effects:

Dye concentrates	*Bronze*	*Gold*	*Brass*
Yellow	—	90	260
Brown	250	30	60
Black	300	—	—
Red	30	20	20
Amber	—	—	60

Flameproofing Preservative for Cut Foliage. A specially developed preservative for treating foliage is a water emulsion available as C & S flameproofing preservative No. 4.[g] When sprayed onto

Fig. 13. New method of removing wallpaper from flats using peel paste.

foliage, it deposits a flexible film of high strength on the leaves sealing their surfaces against oxidation and rapid loss of moisture and other volatile substances contained in the foliage. This film strength prevents the foliage from disintegrating even when subjected to violent flexural abuse.

The compound is certified by the California State Fire Marshal as an approved flame retardant for either interior or exterior use on leaves, brush and foliage. The colors used in the preservative are light-fast and will not bleed. Coated foliage subjected during three months to extended exposure from high-intensity arc light, ultraviolet radiation and infrared rays has not lightened in color nor noticeably darkened. The preservative coat has a high gloss similar to that of the upper surface of natural leaves. The coating is translucent and does not block out the translucency of the natural leaf.

The preservative is applied simply by a pressure-pot spray-gun system using an external mix-head on the gun. A plain trough or hood arrangement will allow additional economy by catching unused material, thus reducing costs since this material can be re-used after straining. Additional information and suggestions are obtainable through the supplier.

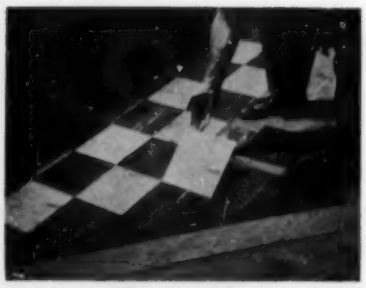

Fig. 14. Tile flooring laid down with peel paste adhesive.

Special Effects Technology

Below are described a limited number of effect items which play an important part in motion-picture production. Not included are purely mechanical effects such as those obtained with equipment producing wind, rain and waves. Explosive effects are also omitted.

Use of Cellophane for Miniature Water-Effects. A platform is constructed with a Masonite top which is painted a blue color. Over this, a continuous sheet of cellophane is mounted, fastened only by the edges. The cellophane sheet is made up of strips joined together on the bottom side with cellophane tape. The cellophane is crinkled by hand, the size of the crinkles decreasing towards the horizon to give perspective. Small fans are placed in front so as to create a gentle flow of air between the cellophane and the Masonite surface and also over the top of the cellophane sheet. Either air current alone would tend to hold the cellophane sheet in one position while the combination of the two currents creates a striking undulating effect.

Properly placed in the miniature set and lighted to give specular reflections broken up by the crinkles, the result will be an extremely realistic illusion of a sea scape, obtained at low cost (Figs. 15 and 16).

A comprehensive paper dealing with required calculations for miniature water effects is recommended for study.[7]

Snow Effects. For falling snow, where the proper type of cornflake is not available, the most popular material is Styrofoam which is supplied for this purpose in ground form with as little fines or dust as possible.[bb] The material is thrown by hand into the air stream of large fans mounted on elevated platforms. For outdoor locations or sets, foaming agents mixed with water and air are used in equipment similar to that employed in fire fighting. To create falling snow flakes effects, the foam is ejected through a perforated spinner mounted in the center and in front of a huge propeller fan. The best foamers for this purpose are lauryl alcohol sulfates.[cc]

Fig. 15. Construction view of miniature with cellophane water effect, sky backing and cardboard cut-outs of hills.

Fig. 16. Composite view of foreground set and cellophane water effect.

For dress snow, salt and crushed rock are still widely used. Contouring of roofs and ground is done with plaster over excelsior stuffing (Fig. 17).

The foam-snow, just described, is also successfully ejected through fire-hose nozzles for the quick dressing of outdoor sets. The material clings well to slanted and even vertical surfaces. It should, however, not be used on vegetation such as lawns and shrubbery.

A dry lightweight snow for set dressing, inside and outside, has recently been introduced and has proven most satisfactory. It is a perlite-type granular material free from fines, each particle coated with calcium chloride. The product, marketed under the brand name "Arti-Snow"[dd] is low priced and can be easily distributed for dressing by hand or with hoppers. It takes footprints and vehicle tracks particularly well (Fig. 18).

Cobwebbing. Good webbing spray-lacquers are commercially available for this purpose under the trade name "Bridgeover"[ee] and "Cocoon Webbing."[ff] A suitable product can also be compounded by preparing a 20–30% solution of Saran F-120[e] resin in toluene. The cobwebbing is produced with ordinary paint spray guns.

These webbing lacquers, in combination with vinyl lacquers, (Spraypeel,[ee] Cocoon-Coating[ff]) which form tough, peelable films when sprayed on top of the web, were originally developed for protection of Army and Navy equipment against corrosion in storage and overseas shipment. They are quite successfully used in studio application to fabricate lightweight rocks. The rock is shaped and contoured from chicken wire which is then sprayed-over with these compounds (Fig. 19).

Fog and Smoke Effects. An effective and simple method of creating fog is herewith described. An insulating handle is attached to a heating coil (electric stove). The device is electrically heated and can be carried around the set, using an extension cord. Mineral oil, when sprayed with a paint gun or a hand-operated atomizer onto the heated coil, will produce copious volumes of dense white fog. Channeling the fog through wooden ducts over wire baskets filled with dry ice improves its stability and causes it to stay close to the ground (Fig. 20). Black and colored smokes are commercially available in the form of powders or candles.[gg]

The methods selected for this report are being successfully used in motion-picture studios and appear equally applicable for independent production requirements. Those interested in using the given information as guidance for fabrication may desire additional data and assistance, which can usually be obtained quite readily by contacting manufacturers and suppliers of equipment and materials connected with the specific process. Support and cooperation from numerous studio personnel in

Fig. 17. Snow-dressed stage set; crushed rock.

Fig. 18. Snow-dressed stage set; "Arti-Snow."

Fig. 19. Interior set; rocks fabricated with chicken wire and vinyl coatings.

Fig. 20. Interior set, fog effect.

the task of assembling and pinpointing the information is herewith gratefully acknowledged.

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f. Marblette Corp., 37–21 30 St., Long Island City, N.Y.
g. Schwartz Chemical Co., 326 W. 70 St., New York, N.Y.
h. Union Oil Co., 617 W. Seventh St., Los Angeles, Calif.
i. Owens-Corning Fiberglas Corp., 16 E. 56 St., New York, N.Y.
k. Lucidol Division, Novadel-Agene Corp., 1740 Military Rd., Buffalo, N.Y.
l. Nuodex Products Corp., 830 Magnolia Ave., Elizabeth, N.J.
m. Allied Chemical & Dye Corp., Barrett Div., 40 Rector St., New York, N.Y.—*Plaskon*
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Rohm & Haas, 222 W. Washington Sq., Philadelphia, Pa.—*Paraplex*
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p. Carbide & Carbon Chemical Co., 30 E. 42 St., New York, N.Y.
q. C & S Coatings Co., 10867 Venice Blvd,, Los Angeles 34, Calif.
r. Monsanto Chemical Co., 1700 S. Second St., St. Louis, Mo.
s. U.S. Plywood Corp., 55 W. 44 St., New York, N.Y.
t. Blue Diamond Corp., P.O. Box 2678, Terminal Annex, Los Angeles, Calif.
u. Poly Resins Co., Sun Valley, Calif.
v. Rohm & Haas Co., 222 W. Washington Sq., Philadelphia, Pa.
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aa. Great American Color Co., 2512 W. Ninth St., Los Angeles, Calif.
bb. Broadway Nursery, 1258 N. Westmoreland St., Los Angeles, Calif.
cc. American Alcolac Corp., 3440 Fairfield Rd., Baltimore, Md.
dd. Redco Inc., 11831 Vose St., North Hollywood, Calif.
ee. Eronel Industries, Hawthorne, Calif.
ff. R. M. Hollingshead Corp., Cooper & Hollingshead Su., Camden, N.J.
gg. Special Effects Manufacturing Co., Pacoima, Calif.

Filming an Educational Television Series

By REID H. RAY

Production techniques used in filming 39 half-hour television shows by a commercial film company are described. An educational type of program (originally televised "live," but not kinescoped) required a format unlike the entertainment television film. Studio-set design, preproduction conferences, lighting, camera procedures, props and special effects peculiar to these films are outlined in this paper.

A TELEVISION PROGRAM which is not in the entertainment category is usually classified as "educational." The series of films described in this paper present "how-to-do-it" home projects and, therefore, are educational in content but are sold to a commercial sponsor. It was the aim of the producer to make the films as economically as possible, so that the selling price would appeal to prospects not interested in entertainment filmed shows.

Fortunately, an established "live" television program was made available to the producer. This show was *Walt's Workshop* which had been televised for five years in the Chicago market. It continues to be telecast "live" each week sponsored by a large retail lumber company. The nonprofessional actor, or star of the show, is Walt Durbahn, an experienced carpenter craftsman and educator who taught in the Highland Park (Illinois) High School for many years. With a five-year backlog of "how-to-do-it" programs, subject matter was plentiful.

The first approach to filming the series started with the producer attending rehearsals and observing the telecasts with the NBC producer and Walt Durbahn. It was then possible to prepare a cost estimate for producing the shows on film. This preliminary estimate included eight hours shooting time for each 26-min subject and provided time and costs for preparation of materials. Each film presented one "how-to-do-it" project, and a few titles of the films give an idea of the projects:

(1) *Walt Builds a Work Bench*
(2) *Walt Builds a Sand Box*
(3) *A Barrel Chair*
(4) *Building a Garage*
(5) *Repair of Screens*
(6) *A Room Divider*
(7) *Cement Work*
(8) *Tool Cabinet*

A set was built in the studio to represent a typical workshop in a home (Fig. 1). All but four of the 39 shows were produced on this set. Two other shows required extensive sets in the studio — one on *Roofing* (Fig. 2) and the other, *Enclosing a Porch*. All the projects built were shown in their completed state and, when required, standing sets in the studio were used to show the installed finished work. In *Building Kitchen Cabinets* the cabinets were installed in a standing kitchen set in the studio. In the 39 films produced, 85% of all footage was made on the workshop set. This was required to keep production costs within the budget.

The shop machines used included a band saw, table saw, jig saw, drill press, lathe, joiner, grinder and a large assortment of hand tools and accessories. Many interesting and unusual sounds were recorded during filing, boring, sawing, grinding, planing, sanding and even marking lines on rough surfaces.

To allow other studio production to be scheduled, only two shows were filmed each week. Due to Walt Durbahn's live television show in Chicago on Friday evenings, he was available only Sunday through Wednesday noon, so a weekly schedule was set up as follows: A preproduction conference took place Sunday evening upon Durbahn's arrival in Saint Paul from Chicago. The materials for the projects to be filmed that week were on hand precut and some of them partially assembled. Often the projects to be constructed would be prebuilt and ready in three progressive stages — material rough cut, a partial assembly, and a completed unit, painted or decorated, or requiring only a door to be completely assembled. At this Sunday meeting, the assistant director and Durbahn would discuss and time-out the various steps of the first project. The second film would be briefly discussed, and the materials required checked. Because each film had a related how-to-do instruction sheet for homeowners, this art work, or finished printing, required advance planning too.

Production began Monday morning with a director, assistant director, script girl, two camera crews a sound crew, grips and electricians; total crew —

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Fig. 1. Workshop set in studio.

Fig. 2. Studio set built for *Roofing Film*.

Fig. 3. Typical opening shot of film subjects.

Fig. 4. Two-camera set-up for live sound.

twelve. After the first two films were produced, very little advance preparation for shooting was needed as practically every subject began with a close-up of Walt and dollied back to a medium shot of the workshop, or the reverse (Fig. 3). The lighting units used were: one 5000-w key light, four or five 2000-w back lights, and one or two 1500-w fill lights. For close-ups requiring special lighting, 750-w spots and various reflector-flood type bulbs were used. On those films produced on location, two 150-amp arcs were used as key or background light. These arcs required portable generators, adding to the cost of production.

Those films made on location required more time than the budget allowed due to numerous weather delays of from 15 min to 2 hr. One film was delayed due to rain and production had to be suspended with only 50% of the film completed. It was completed, however, the following week. Considerable difficulty was experienced also in recording sound out of the studio because of normal residential street noises.

All pictures were shot without a script and the dialogue originated on the set as each scene was rehearsed (Fig. 4). Sound-recording technique was "live" or "sync-sound" on all takes. When the two cameras were operating, the No. 1 camera used a 40mm lens covering a medium-shot area and, by dollying, moved into close shots. The No. 2 camera, operating 80% of the time, covered close-ups with either a 75mm or 100mm lens. When extreme close-ups were made, one camera was moved in and a special set-up made for accurate focus and lighting. In some close-ups both cameras were moved in close, and two angles were shot so that the editor had a choice in selecting the angle in which the work being done photographed best. Macrophoto close-ups were used to bring out small details, and in these shots lens extension rings were added. Many of these extreme close-ups required "live" sound. One of the assistant cameramen, getting into the "do-it-yourself" mood put together a miniature clapstick with spring-actuated finger-tip control (Fig. 5). This aided considerably in slating tight close-ups.

In lining up for close-ups, particular attention was given to the limits of the camera picture area as seen on the ground glass of the camera, so the entire action would be seen when telecast and received on the home TV set. When rushes were projected in the screening room,

Fig. 5. Miniature clapstick designed and built by Asst. Cameraman Lambert.

a special aperture was used in the 35mm projector of the approximate dimensions of the image telecast by television stations. In that way, the film editor was sure that the action in the scenes would not be cut off when televised.

Each subject, in addition to showing how to build a project or repair some item around the house, was planned to present helpful ideas, or new methods of shop work to the viewer. In all films time was devoted to the proper method of handling shop tools or how to select the right tool for the job, or sharpen a chisel, or select a hammer. Films of this type should be photographed, whenever possible, from the "user's" viewpoint — sometimes called the "operator's" viewpoint. The action should be deliberate and not hurried and editing must allow the audience to absorb completely each step shown. Large close-ups play an important part in the "how-to" films whether for television or for educational film distribution.

All sound was recorded simultaneously on both $\frac{1}{4}$-in. tape and 35mm magnetic film. Without the aid of a script, playbacks were used more often than in producing a film from a script. The only record of what had been said was recorded and the flow of continuity was maintained easily with the use of playbacks. To check the last few sentences recorded, when work resumed after the lunch-hour, or at the start of the second day of shooting, the playback proved invaluable. Whenever a playback was required, it was found that it took less time using the $\frac{1}{4}$-in. tape than the 35mm magnetic for this purpose. If any close-up inserts were re-shot silent with a previously recorded sound take, the $\frac{1}{4}$-in. tape was played back to match the action being photographed.

To maintain the proper contrast between the actor, the set, and wood materials photographed, it was necessary to "make-up" the raw lumber, especially if it had been dressed or finished. A solution of one part oak stain to three parts linseed oil was used, and was applied lightly with a cloth and then rubbed with a second dry cloth to obtain a smooth, even coating.

Because these films were produced without the aid of a script, it was essential that the timing of each scene be known and a cumulative total available at all times. It was found that by subtracting 10% of the actual time of each scene, a fairly accurate *edited* time would be known in advance. As an example: if 8

scenes totaled 16 min of action photographed, 10% less resulted in 14 min 24 sec as the approximate screen time for the 8 scenes. The average film footage delivered to the Editing Department was 31 min in length. The shortest film time to edit was 25 min, and the longest 40 min. The film editor and the director decided what could best be eliminated and still give a comprehensive presentation within the overall length of 26 min 20 sec. A Moviola with double 35mm picture heads and optical soundhead was used to edit the two picture prints into an interlock work print.

In summary, 39 26-min films were produced on a final schedule of two films produced per 2½ days, or approximately ten hours of shooting time per subject. This was possible because of preproduction planning, prefabrication of materials and projects, a knowledge of training film techniques, full cooperation of the camera, sound and electrical crews, and last, but not least, the untiring and skillful ability of the star of the show — Walt Durbahn.

Multiple-Camera Control

By IRWIN A. MOON
and F. ALTON EVEREST

In the photographic phase of certain types of motion-picture film production, multiple-camera operation is of great economic value. This paper describes a simplified system by which four or more standard blimped cameras may, by push-button control, be started and stopped at will during sound takes with automatic head and tail sync marks. Short-cut editing procedures using the film from such multiple-camera operation are also described.

THERE are certain lessons which the motion-picture producer can learn from the television industry. Multiple camera operation in covering television productions is a commonplace procedure. Inasmuch as the pictures from each camera are in the form of electric currents, "editing" by the producer is simply a matter of switching circuits. Until that future date when photographic emulsions are replaced by magnetic recording of electrical signals representing the image, there are certain modifications of present-day motion-picture film production techniques which are practical and in many cases highly desirable economically. The multiple-camera system to be described combines the flexible features of the television system with the inherent advantage of film in being able to select material.

System Operation

Multiple-Camera Photography. The block diagram (Fig. 1) shows the principle of operation of this system. The starting and stopping of any camera is accomplished by pushing the start or stop buttons on the director's camera-control box. Visual synchronization is achieved by means of a "flag" or metallic vane which momentarily cuts off the light to the lens. This is a solenoid-operated device mounted on the matte-box supports as shown in Fig. 5A. Aural synchronization is achieved by means of a cue tone which is recorded on a standard magnetic recorder. A separate tone is used for each camera. In the present case it was expedient to use the frequencies 1040, 1300, 1600 and 1990 cycles/sec. For example, as camera 2 is started, a 1300 cycles/sec tone is recorded on the cue recorder. If all four cameras are in operation simultaneously, all four frequencies will be recorded on the cue track, mixed in a linear network. In other words, while a given camera is running, its associated cue tone will be recorded. For ease in picking out any camera starting and stopping points a raw a-c signal is recorded during the brief period that the button is depressed.

Inasmuch as care has been exercised to make all parts silent in operation, cameras may be started and stopped at will during a sound take without causing a disturbance in the picture sound microphone circuit.

Table I gives the status of the various components during the starting, stopping, running and resting conditions. As a camera start button is depressed the camera flag immediately shuts off light to the lens and the camera motor is energized, coming to synchronous speed very rapidly. As the button is released the flag opens and the cue-signal circuit is closed. This characteristic cue tone then continues while this particular camera is running. As the stop button is depressed, the camera flag immediately closes and the cue tone stops and the motor begins to stop. It will be seen that the visual synchronization point is the first picture frame on the head end after the flag opens and the last picture frame on the tail just before the flag closes. These two points coincide with the beginning and cessation of the cue tone. Figure 2 illustrates the visual head and

Table I. Sequence of events as single camera is started and stopped with automatic head and tail sync.

Camera condition	Control button condition	Camera flag position	Camera motor	Cue signal
Resting		Open	Stopped	Off
Starting	"Start" button depressed	Closes	Starts	Off 60 ~ a-c tone starts
Starting	"Start" button released	Opens	Up to speed	60 ~ a-c tone stops. Cue signal begins instant flag opens
Running during take		Open	Synchronous speed	On continuously
Stopping	"Stop" button depressed	Closes	Starts to stop	Stops instant flag closes 60 ~ a-c tone starts
Stopping	"Stop" button released	Opens	Stopped	60 ~ a-c tone stops

Presented on April 19, 1955, at the Society's Convention at Chicago by Lewis H. Humphrey for the authors, Irwin A. Moon and F. Alton Everest, Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles 25.
(This paper was received on April 1, 1955.)

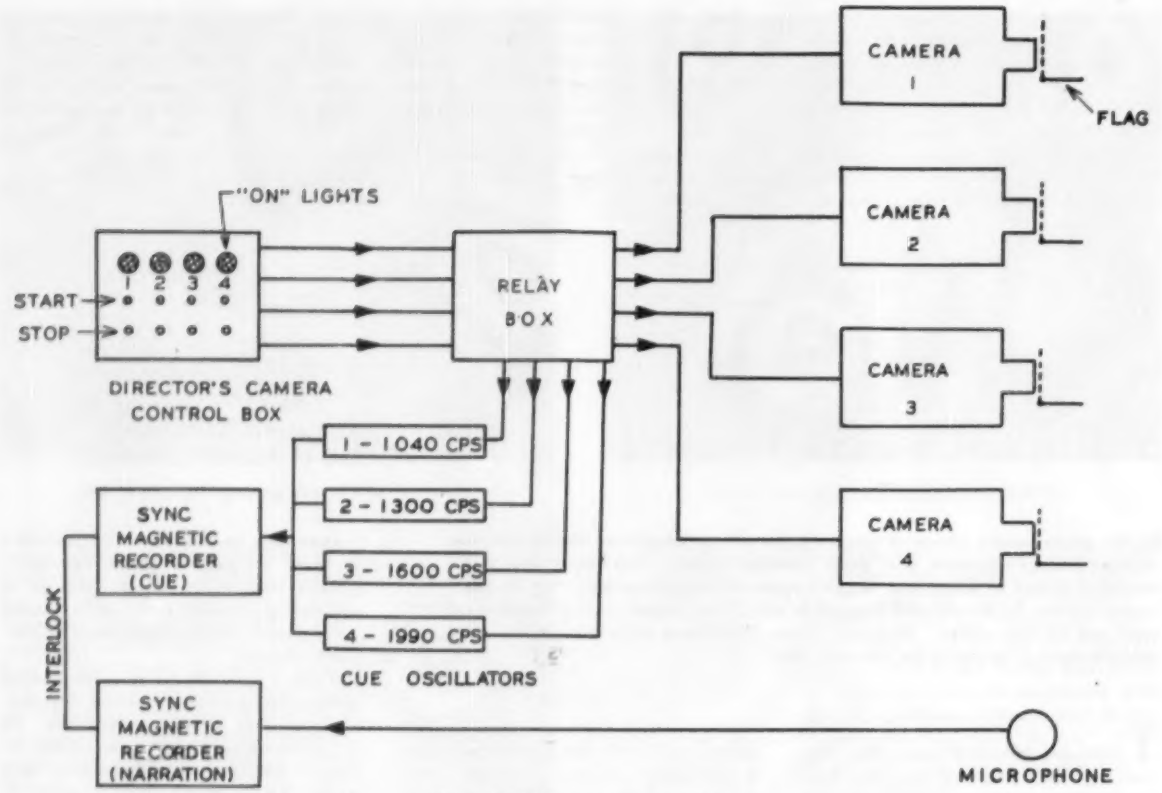

Fig. 1. Multiple camera operation.

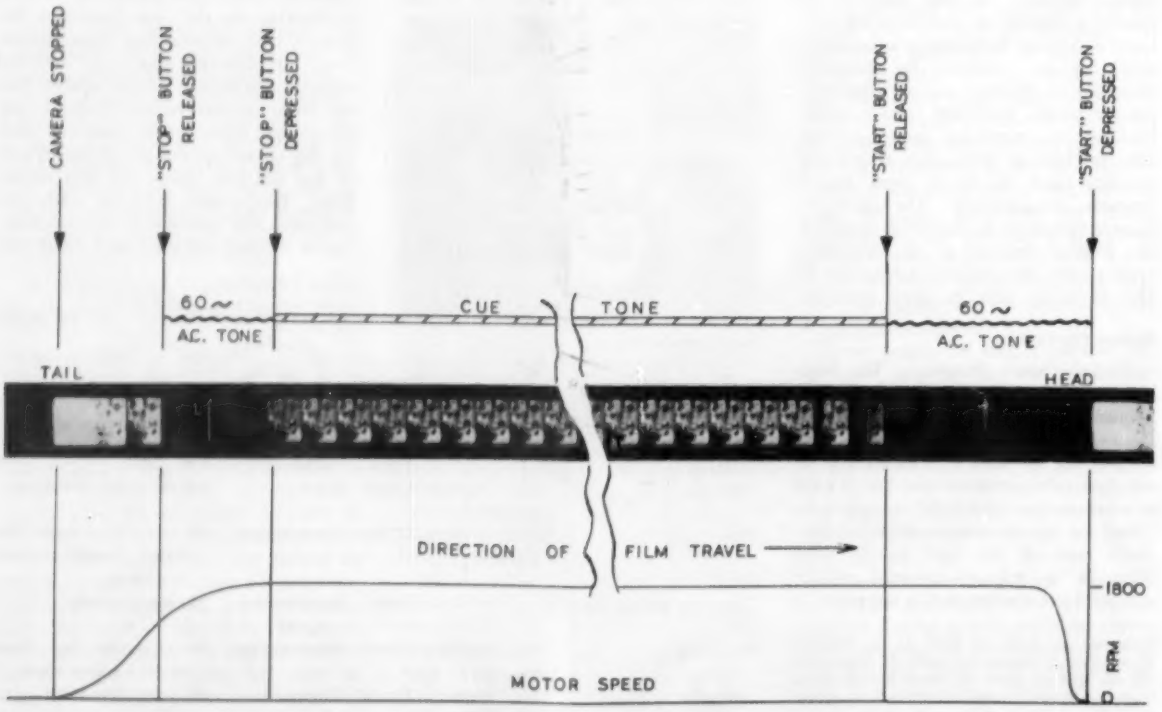

Fig. 2. Camera-operation cycle.

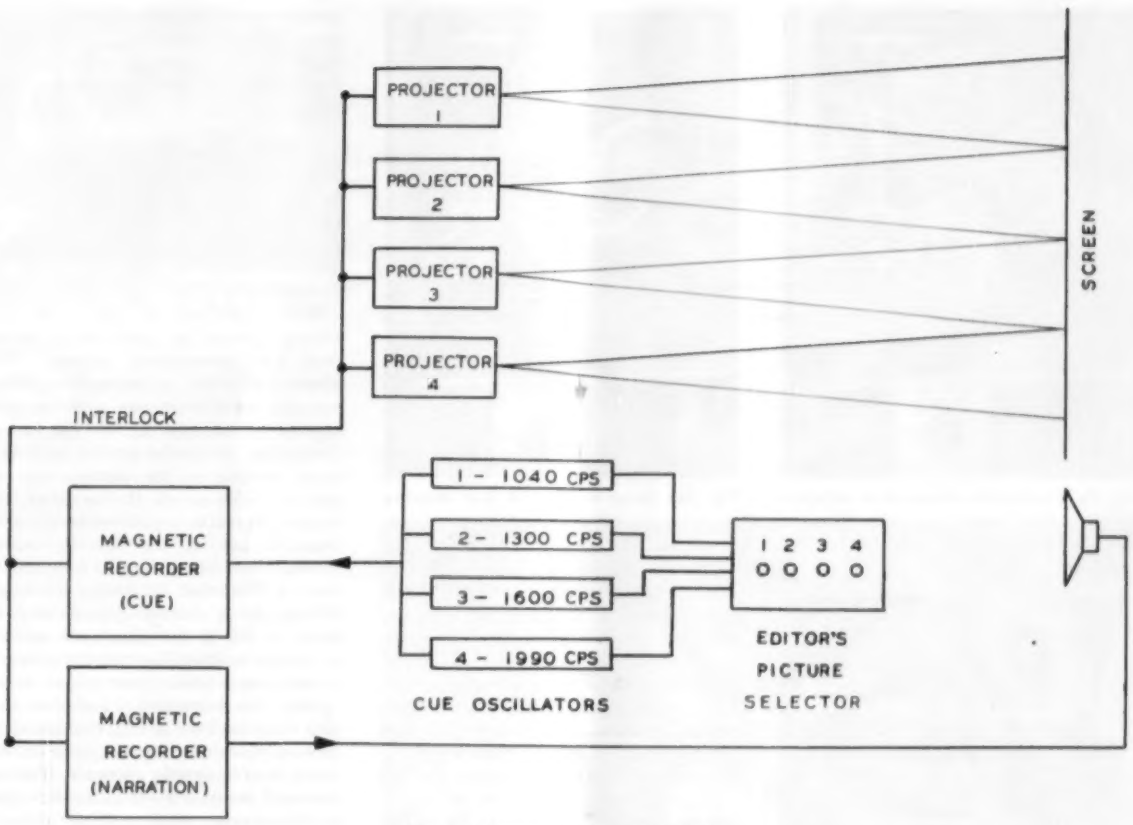

Fig. 3. Editor's selection projection.

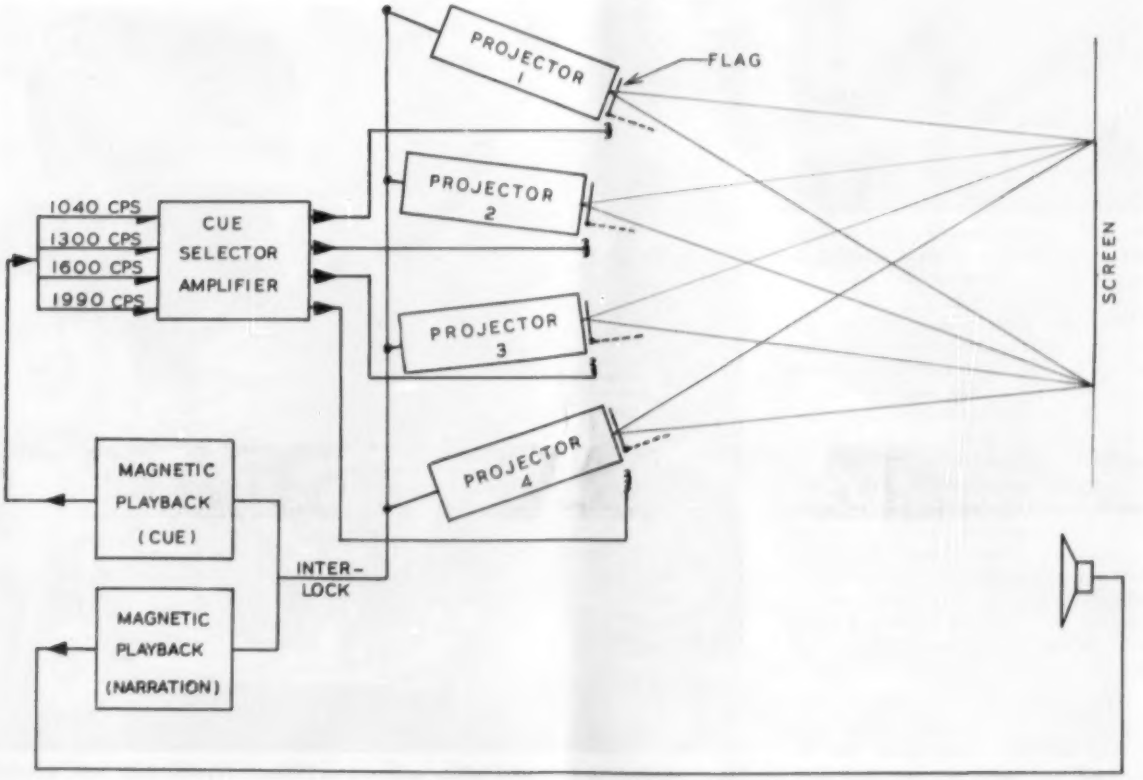

Fig. 4. Editor's cue-controlled projection.

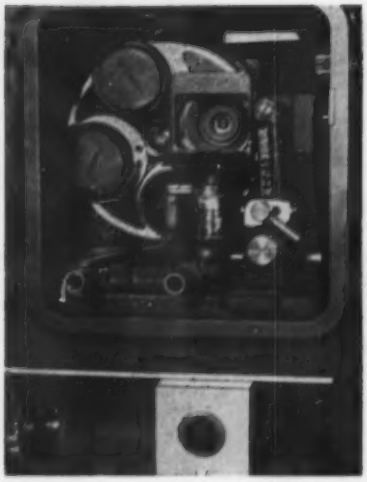

Fig. 5A. Camera flag mounted in Mitchell 16 blimp (lens hood removed); "Camera On" indicator light mounted below camera.

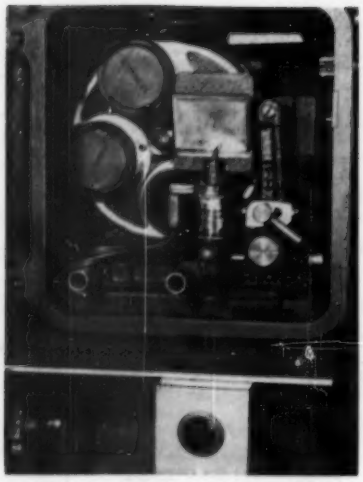

Fig. 5B. Same as Fig. 5A but showing "flag" closed.

Fig. 6. Camera control cart showing director's camera control box, bell, cue oscillator, and relay box.

tail synchronization on a typical take, as coordinated with cue tone and motor speed. In order to synchronize the picture and cue tape to the narration tape a single-stroke bell has been incorporated which rings the instant the start button of the first camera to be started is released. The subsequent starting of any other camera during the take sequence does not cause the bell to ring. All cameras must have stopped before the bell will ring again. To synchronize the narration tape it is necessary only to parallel the beginning of the bell sound with the beginning frame of picture and start of cue tone.

Multiple Viewing. One economic advantage of this system is that great savings in film consumption can be realized by turning certain cameras off when the particular angle is not desired or usable. To prepare rushes from all cameras for simultaneous viewing, leader must be spliced in during the time any camera was off to establish parallel synchronism.

If two or even three cameras are used, it is possible to differentiate and identify the different cue tones by ear. With four operating simultaneously, however, we have found it desirable to play the cue tones back through a cue selector amplifier so that the footage may be logged for the start and stop of each camera. Armed with this information, the editor's assistant may easily establish parallel synchronism between all pictures and sound.

Editor's Selection Projection. In viewing the rushes it has been found successful to view all pictures simultaneously, projected side by side on a wide screen as shown in Fig. 3. The quality of the takes from the various cameras can readily be ascertained by glancing across the screen.

It was decided to accomplish the editing process by pushbuttons rather than the conventional scissors. This allows the editor to concentrate all his energies on the creative and aesthetic aspects unencumbered by mechanics. The editor sits in the special projection room viewing all the pictures side by side on a wide screen. He has before him a small box with a pushbutton for each channel. Let us say that he pushes button 1 indicating that the long shot of camera 1 is what he desires for establishing. At a certain critical time he wants to cut to the scene on camera 3 which he indicates by pushing button 3 at the proper time. Upon certain action he may cut to camera 2 and then to 4 and then back to 1, etc. Pushing these buttons sends characteristic channel cue tones to a magnetic recorder. Pushing button 1 sends a 1040-cycles/sec signal to the recorder while pushing button 2

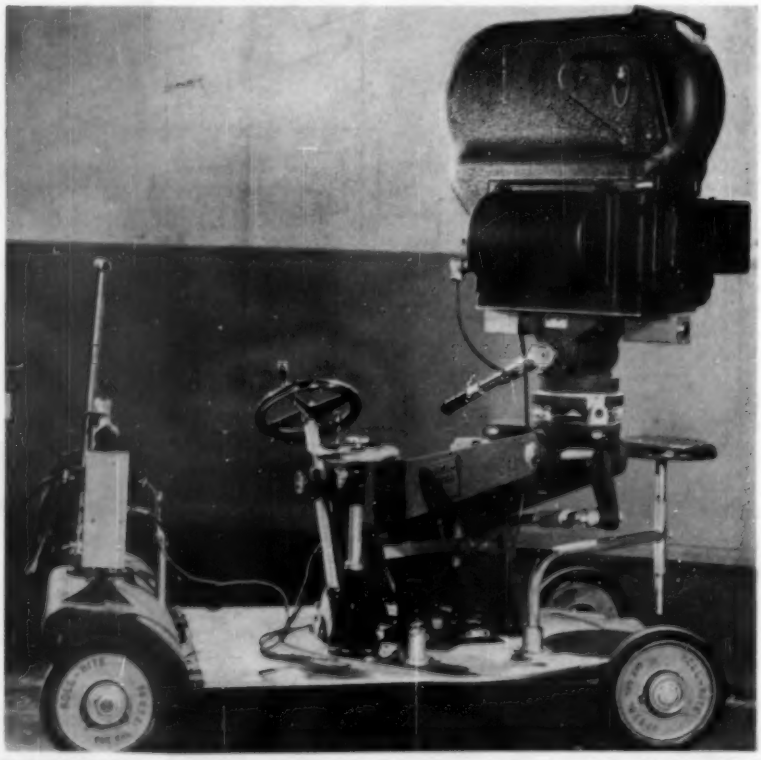

Fig. 7. Mitchell 16 with 1200′ blimp mounted on Houston-Fearless dolly with terminal box for sync control.

Fig. 8. Cameraman's control box mounted beneath blimp for individual control.

sends 1300 cycles/sec, etc. The editor thus builds a cue track which is the control for his first cut version. If this version is not satisfactory he may erase his cue track and build another.

Cue-Controlled Projection. In Fig. 4 is shown a system by which the cue track built by the editor's pushing of buttons can now be placed in control so that to all intents and purposes a cut version of the film can be viewed. In this case all the projectors are adjusted so that they illuminate the same area on the screen. Each projector is equipped with a flag similar in design to that used on the camera except that for the projection case it is normally closed. When a cue tone of 1040 cycles/sec comes through the cue selector amplifier it causes the flag on projector 1 to be pulled down, allowing the image of the film in projector 1 to be seen on the screen. As soon as this 1040-cycles/sec cue tone ceases, this flag will return to normal, cutting off the light from projector 1. As the editor can only select footage from one camera at a time, only one projector flag will be open at a time. The picture on the screen will then appear as though it actually were cut according to the decisions of the editor.

At this stage, supervisory personnel and responsible officials can be called in for a viewing. If the result is satisfactory, a composite print can be made by the A, B, C and D roll zero light printing technique. If the volume of prints desired rules out this technique, the picture master may be cut in the normal way.

Relay Box. The basic control elements of this multiple-camera photographic system are a locking-in type of multiple-pole relays. These may be either the electrical lock-in or the mechanical latching types. These relays are closed and opened by pushing the start and stop camera-control buttons. Closure of one of these relays: (1) applies power to its camera motor; (2) raises the camera flag; (3) closes its cue-tone circuit; and (4) energizes indicator lamps on director's camera control box, at the camera operator's position, etc.

Cue Oscillators. The cue-tone generators are simple resistance feedback type Wien-bridge stabilized oscillators which give excellent frequency stability without source-voltage stabilization. Frequency-stability requirements are determined by the filter passbands in the cue-selector amplifier. The outputs of the several cue oscillators are combined in a conventional resistance network. Care should be observed to maintain sinusoidal waveform as harmonics of sufficient amplitude could cause spurious operation in other channels. The level of the mixed output of the cue oscillator should accommodate the input requirements of the cue-tone recorder, normally about 0 dbm.

Editor's Picture Selector. The editor's picture selector switch is a conventional mechanical interlocked mechanism, which automatically releases the button, which is down when another is depressed. Its sole function is to switch appropriate cue tones to the cue recorder.

Cue Selector Amplifier. The heart of the cue selector* is a conventional audio amplifier which has a parallel resonant circuit connected between input grid and cathode. Only at the frequency to which this circuit is tuned does a high impedance exist in the grid circuit. Signals of this frequency applied to the grid will develop relatively high voltages which are amplified and passed through the channel. Signals of other frequencies are discriminated against. Each channel uses the same circuit with grid circuit

* The present selector was adapted from a salvaged war-surplus amplifier used in radio control of drone airplanes.

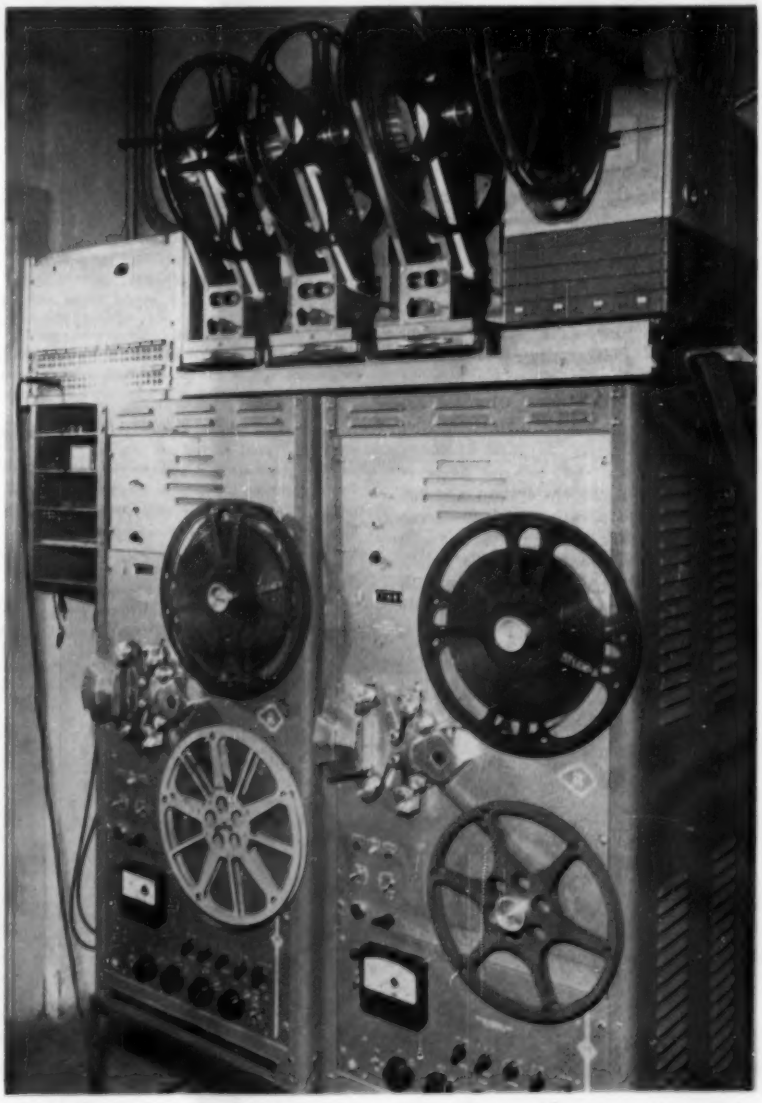

Fig. 9. Projection set-up showing three sync projectors and two magnetic recorder playback, all units interlocked.

Fig. 10. Three camera set-up on sound stage with audience.

tuned to its characteristic frequency. The cue-tone signals are applied to all channel inputs connected in parallel, the different cue tones being separated out by the tuned inputs.

The signal output of each channel is rectified and the rectified current operates a relay which operates (1) the projector flag for cue-controlled projection, or (2) an indicator lamp for logging camera starts and stops in preparation of rushes for double-system viewing.

Conclusion

This multiple camera system appears to have many operative and economic advantages under certain quite common film production conditions. It is applicable to the small organization with limited budget as well as to the larger ones.

Acknowledgment

The authors wish to express their appreciation to the following Moody Institute of Science staff members who have contributed to the development of this system: Lewis H. Humphrey, Estes C. Wright, Earl Nelson, Leonard Hughes and William Green.

A great debt of gratitude to William V. Stancil is acknowledged for his technical counsel and interest throughout the project. Commercial development of the system will be by the Stancil-Hoffman Corp.

Discussion

Lester E. Bernd (Delaware Steeplechase & Race Assn.): Regarding the projector synchronization, are the projectors mechanically interlocked?

Lewis H. Humphrey (who read the paper): No, they are electrically interlocked.

Mr. Bernd: Then that would allow you to separate the projectors for editing purposes. May I ask what make of projectors was used?

Mr. Humphrey: They are Bell & Howell silent projectors which we have rebuilt with torque motor take-ups and a selsyn interlock motor for drive.

Ralph Sogge (Purdue University): What type of recorder is used for the cue tones?

Mr. Humphrey: We use the Stancil-Hoffman 16mm recorder, the same as we use for narration.

George Lewin (Signal Corps Pictorial Center): Can you expand this system so you can get dissolves?

Mr. Humphrey: You mean in the printing?

Mr. Lewin: Well, even in the viewing?

Mr. Humphrey: Oh no, we haven't even considered that. It could be done. It might be a little difficult though. The vane would not normally cut off your light in the way that you want it to be cut off for a dissolve. An iris control would be better for this application.

Mr. Lewin: Could you elaborate on the use of the bell?

Mr. Humphrey: The bell is the only means we have of synchronizing the narration tape with the cue tone tape. There is no signal put in the narration that would correspond to the cue tape, so we must have some audible signal which we use to synchronize that tape with the picture and cue tone tape.

John Tyro (Indiana University): In the projection situation I noticed that you use the same flag. Have you tried controlling the projection lamp?

Mr. Humphrey: We have thought of that but the main difficulty is that as it is cut off it takes a long time, relatively speaking, for it to really cut down; therefore, it would project an image for several frames. It would be all right for viewing but wouldn't be quite as good as if you could cut it off with a vane or flag instantly.

Jerome Joseph (Federal Civil Defense Admn.): You say that the bell is used for your audio cue but if you leave your first camera on and you cut over to your second camera, does the bell go off again?

Mr. Humphrey: No. Once you start a camera and then start any other camera during that same take, the bell will not ring again. It will not ring with any other camera that is being started until all cameras have stopped. Then when you start again, the bell will ring.

Mr. Joseph: Then how do you know you're in sync with your second camera?

Mr. Humphrey: Your cue tape has not stopped. It goes continuously for the duration of the take and all you have to do is bring the picture in to your cue tape when your cue tone starts and sync them up that way.

Mr. Joseph: You said when you are viewing your takes you have your three projectors side by side and you are viewing simultaneously three films. Now you say that sitting in the control room the editor can cue any projector he wants, that is, in the first viewing of the three films. Now does that cue just come up on a footage indicator?

Mr. Humphrey: No, you are running another cue tape and recorder on which you record signals which become your control for projection back again.

Mr. Joseph: Then all you do is really run the three projectors against your cue tape which gives off electrical impulses which will cut in No. 1, No. 2 or No. 3 projector as it was indicated. And if you want to change, all you need is to make another cue tape?

Mr. Humphrey: That is it exactly.

16mm Away From Hollywood

By ROBERT W. SWANSON

The small, independent, motion-picture producer using production ingenuity has placed industrial films within the range of small industry. This is the story of one of these producers in a city of 32,000.

Breaking the Barrier

Perhaps the greatest contribution of the small, independent, motion-picture producer has been the placing of sound motion pictures within the range of small industries. Breaking through the "thousand dollar a minute" barrier required public education, production ingenuity and application of technical advances in 16mm filming. Once through the barrier, as in the field of jet aviation, new vistas were opened.

This paper is not presented as a rebuff to high-budget industrial films. Rather, we are attempting to explain how quality pictures can be produced for industries lacking the financial ability to absorb high screen costs. Low budget films, although owing their very existence to low costs, must attain the high standards set by the major producers. No company, with today's competitive economy, wants nor can afford inferior motion pictures just for the sake of conserving advertising dollars.

The Beginning of an Independent

This is the story of a small producer making pictures on a low budget — on a "do-it-yourself" basis 2800 miles from Hollywood.

Presented on April 19, 1955, at the Society's Convention at Chicago by Robert W. Swanson, Rudy Swanson Productions, 1616 Lehmann Lane, Appleton, Wis.
(This paper was received on April 19, 1955.)

Rudy Swanson Productions is located in Appleton, Wis., a city of only 32,000 in a population node called the Fox River Valley. Overlooking the Fox River, as it meanders from the central part of Wisconsin to Green Bay, is one of the nation's richest industrial areas. It is the heart of the paper and paper products industry. Kleenex is made here, and most of the paper for Life magazine. The list is long and impressive.

It is here Rudy Swanson Productions started. In the early 1930's, Rudy Swanson was a teacher in the Appleton public schools. Teaching business science in the local junior high school gave him the opportunity to use visual aids. If the motion picture could be used in the class room for teaching, a test of retention at its very best, why couldn't it be applied to industry?

A Camera, Tripod and a Book

In 1936 Swanson purchased an Eastman Special, a tripod and a book on making home movies. Using his summer vacations, Christmas and Easter holidays and week-ends, he started to master the mysteries of early Eastman color film. An outdoor enthusiast, he produced sport and fishing pictures for South Bend Bait Co. and Evinrude Outboard Motors.

Lecturing with these silent sports films put Rudy Swanson in contact with civic and industrial leaders in Wisconsin. Conversations following the lectures often turned to applying the 16mm film to local industry.

The Pioneer Production

However, 15 to 20 years ago companies had to be educated on the power of the motion picture for industrial use. The Fox River Valley was no exception. One of Rudy Swanson's early films, *The Romance of Paper*, was completed in 1938 for the Kimberly-Clark Corp. of Neenah, Wis. It was not a selling picture. Most industrial leaders still clung to the notion that motion pictures could be utilized only for public relations. Selling tools were confined to other media.

This Kimberly-Clark film was silent and shot in old Eastman color. Lighting in the vast darkness of mills presented a great problem. Actors, if any, were found locally. Titles were crude by today's standards. But it was an early use of the industrial film.

Other industries in the Fox River Valley saw it and for all its lack of present techniques, it proved the power of industrial films. Other productions for paper manufacturers followed. Most of them requested pictures with a public relations theme.

All these early productions were shot in Eastman color as Rudy Swanson felt color was important to the story of products and mills. To achieve exposures in dimly lighted mills required banks of photo floods — a cumbersome method, but the end product was worth the effort.

Pictures Could Sell

Salesmen, when projectors became generally available, showed these early

Fig. 1. Up-to-date editing equipment is a great cost and time saver for the independent producer. Editing time on technical industrial films often exceeds 300 hr.

Fig. 2. The sound control room of Rudy Swanson Productions.

pictures to clients. Mill operations took on new meaning and orders became easier. It was at this point that the selling picture was born. The "trip through the mill" film was general in scope. It touched lightly on all products made by the company. Salesmen saw a need for a picture on a particular type of operation, machine or product.

The Professional Touch

Industrial pictures now reached an audience far away from the factory site. Salesmen wanted a soundtrack to point out selling features of the product. Overlays, narrators and music were called for. Being 2800 miles from the west coast production centers, we looked for a professional laboratory, nearby, to supply these needs. Chicago presented our best opportunity, although at that time this service was just starting to be developed. The laboratories helped in many ways to give our early sound pictures the professional touch.

Increasing Costs

Increasing the technical skill of our films also increased our costs. Hiring editors, sound engineers, lip-sync camera crews and sound stages was a necessary but costly expense. The first step toward "do-it-yourself" was the acquisition of an editing table (Fig 1). Synchronizers, readers and viewers permitted the cutting of work prints, matching of tracks and conformation of original A and B rolls. On a highly technical industrial film, editing time often runs into 300 hr. The purchase price of editing equipment is minor compared to the savings in labor costs.

The original recording of soundtracks, the re-recording and music and sound dubbing were still farmed out. We feel the greatest help to the independent producer has been the development of magnetic recording. As soon as a good tape recorder was on the market, we purchased a $\frac{1}{4}$-in. Magnacorder. Installed with a sync signal head, this machine was used to record wild narration and lip-sync. The $\frac{1}{4}$-in. was transferred to 16mm optical at a sound laboratory.

Another step in tape development gave our industry the sprocket-drive sync magnetic recorder. Seeing the great use of this machine, we purchased a Kinevox 17½mm machine. Recently we converted our entire sound operation to the 16mm Magnasync line using a Magnasync recorder, dubber and sound mixer (Fig. 2). We now are equipped to make the final re-records. Music needs were solved with the addition of the Capital "Q" music library. Today Rudy Swanson Productions is completely independent as far as any sound requirements are concerned.

The Actor

The use of professional lip-sync actors gives industrial films flexibility. Actors can often convey ideas not easily stated in straight narration. Chicago talent, near to Appleton, meets our needs.

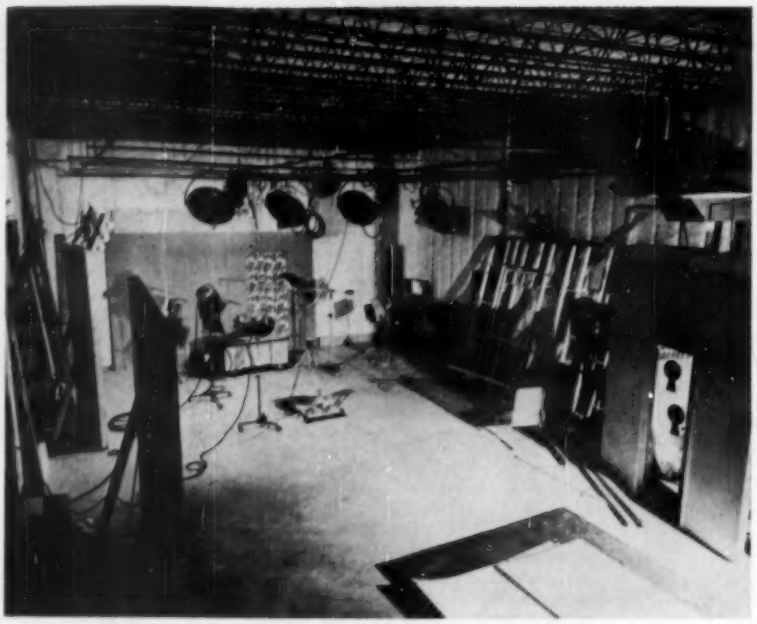

Fig. 3. New sound stage of Rudy Swanson Productions.

Building the Sound Stage

As our productions became more complex, we needed more shooting time in a sound stage. Rental costs in major production centers are costly for good reasons. To compete with pictures using extensive lip-sync sequences required many rental hours. Building our own stage represented a considerable investment; however, with future expansion in mind, we felt the plan sound. In the fall of 1954 we completed construction of a stage with a shooting area of 60 × 40 ft. An 18-ft ceiling gives adequate height for both lighting and acoustics. Dolly shots without tracks are possible on the smoothly poured 8-in. thick concrete floor (Fig. 3).

Owning the stage reduces production costs in set construction. Standing sets can be built and with simple modifications may be used in many pictures, representing savings in cost and production time. A few power tools and a knowledge of set construction produces professional looking sets. Ten-foot flats constructed of light frames serve most needs.

100,000 w of city power supplies the current for the stage. Overall lighting is built up from 5000-w Mole-Richardson sky pans hanging from the lighting grid 15 ft above the floor. Key lights are 5000-w Century Seniors and back lighting is developed from Juniors. Using this amount of lighting allows a camera stop in commercial Kodachrome of $f/4$ on long shots to $f/5.6$ on close-ups.

Summary

In tracing the growth of Rudy Swanson Productions, some conclusions can be reached. The independent producer must take skillful advantage of new labor and cost saving advances in 16mm equipment. Each operation of motion-picture production done in his own shop means the scaling down of costs.

The independent motion-picture producer must provide excellent service to his clients. He is dependent on repeat pictures from a relatively small group of clients for steady employment. A willingness to satisfy sponsors may often overcome the lure of the large producer in a distant city. Proximity is a great advantage as much time and money can be expended by potential clients in traveling to studios in large metropolitan centers.

Being able to handle all phases of production has its personal as well as monetary rewards. The small producer becomes an expert cameraman, editor, sound engineer, salesman and writer. Year after year association with the same clients provides the independent with an invaluable knowledge of products and services he places on film. He becomes "a part" of each company he serves.

However, the "do-it-yourself" method is by no means a panacea. The small producer is sometimes in danger of over-expansion. Idle equipment is costly. His finished product must always compete with the efforts of the large producers with regular staffs.

The significant contribution of the independent to the industrial-film industry is placing the motion picture within the range of most industry. Increased use of industrial films benefits all producers — large and small.

Use of CinemaScope in 16mm Nontheatrical Films

By JERRY FAIRBANKS

The problems encountered and the solutions in the filming of 16mm CinemaScope films for industrial and educational use are described. Methods of exhibition are also discussed.

INDUSTRIAL LEADERS are realizing more and more each day that the commercial motion-picture medium, when properly used, can tell the story of their company, organization or product more effectively than any other existing media. This realization has been aided by the incorporation of every technical advancement in the motion-picture business in order to make the most effective presentation possible.

The latest of these, and one which has created considerable interest is the use of the CinemaScope wide-screen technique which has proven so effective and popular in motion-picture theaters.

When the Chrysler Division planned its 1954 dealer meetings, to introduce the '55 cars, it was vitally important to them that their new models be presented in the most dramatic manner. First impressions are lasting ones and, therefore, it was very important that the first look dealers would get of this new car be as impressive as possible.

The obvious answer was to take advantage of the latest motion-picture technical advancement, CinemaScope. The screen proportions of this new filming technique are ideally suited for motor cars. The enthusiastic acceptance of this suggestion immediately brought to light the fact that a great many technical problems were going to be encountered in order to present the picture in the most effective and acceptable manner.

First of all, since approximately thirty dealer meetings were anticipated, in already contracted locations, it became obvious that some type of portable 16mm equipment would have to be used. All these locations were in hotel ballrooms, civic auditoriums, dining rooms, etc., where 35mm CinemaScope installations were not only nonexistent but impractical as well, in the time allotted and within the budget requirements.

The Bell & Howell Co. was preparing to introduce its 16mm anamorphic lens manufactured under a CinemaScope license, and an order for one of these units had been placed some months previously. In viewing the first demonstrations of the prototype of this lens, it was quite apparent that definition in the film itself was one of the most important critical factors, particularly in the large size picture we required.

A 16mm original Kodachrome reproduced very well because of the crisp definition inherent in a Kodachrome original. Prints from the original, however, suffered considerably in reproduction because of the sharpness loss in printing.

The preceding year in the Chrysler new car picture we had used Eastman 35mm color negative with 16mm color reduction prints made therefrom for the first time. The one outstanding advantage was the noticeable increase in definition in the 16mm prints. This, then, seemed to be the best solution, but now another problem entered into the field.

The Bell & Howell lens was designed primarily for 16mm cameras and it was not certain just how it would work in 35mm. Through the cooperation of the Bell & Howell Co. the delivery of the first lens was expedited so that immediate tests could be made to check the results. It was discovered that the anamorphic supplement worked very well with certain focal-length lenses of the 35mm camera giving sufficient range to permit adoption of this medium for the filming of the picture. The widest-angle lens that could be used was a 58-mm and the longest focal length a 100-mm. Within this range, optimum results without cutoff could be secured.

The next problem to be faced was the projection equipment and the screen to be used. The screen had to be readily portable, and yet capable of being set up in a short period of time and giving the maximum screen surface possible.

The Radiant Screen Corp. of Chicago had just such a screen under development. The largest screen of a really portable nature that could be devised, they felt would give a 21-ft × 8 ½-ft screen surface. This would be supported by a 10-ft × 24-ft aluminum frame that could be broken down for shipment.

Since so many dealer meetings were to be covered in such a short period of time, it was necessary to plan the travel of these units from most points by airline. Therefore, all the equipment had to conform with the ability of the airlines to handle the units when packed for shipment.

The screen presented the greatest problem. The frame when knocked down and packed represented a package 12 ft in length which was the maximum that would fit into an airliner's baggage compartment. As a matter of fact, it had to be a big airliner at that. Several of the schedules had to be rerouted because nothing smaller than a DC-6 could accommodate the size of the units.

In order to secure the most dramatic presentation of the car it was decided that all events leading up to the first glimpse of the car itself would be filmed in normal screen proportion so that at the appropriate moment the wide screen could be used and the car presented for the first time.

This injected additional problems, not in production, but in the presentation thereof. First of all, a set of portable drapes that could be packed with the screen had to be designed and constructed to work on a traveler that would allow the drapes to reduce the screen area to normal picture size for the first half of the film and then on cue to open to the full width of the screen for the CinemaScope presentation.

Even more intricate was the necessity of devising some method of swinging the anamorphic lens into place on the projection machine at the proper moment in the film. The definition problem being as critical as it is, this device which was developed in our shops had to be built to a very fine tolerance with minute adjustments for centering the picture on the screen as well as lining it up optically with the projection lens itself.

A projector had to be secured that not only was portable, but that had an arc light source and a physical construction that would allow for the interchange lens mechanism. The one projector that satisfied these requirements was the new RCA 400 which was not yet on the market but which could be delivered in time. We therefore immediately placed orders for a sufficient number of these projectors and proceeded with our developments.

The next problem was the projection lenses themselves which were surprisingly lacking in uniformity and definition throughout the field. This was a most important point for all our care in trying to preserve definition could be dissipated by the use of an inferior projection lens. Unfortunately, we were

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never able to secure a lens combining both a sufficiently high light transmission with flat-field definition at any price. After numerous tests, the best lenses were found to be Bell & Howell lenses which were then provided with adapters to fit the RCA projector. Even these lenses, however, leave much to be desired. It is surprising that such little attention is paid to such an important factor in the reproduction of 16mm films. Producing companies use extreme care, and go to great expense, to secure the finest optical equipment for use in the filming, but in reproduction practically every picture suffers because of the inferior quality of the lens used, even in the highest-priced projectors.

The next problem was the vast difference in screen illumination between the conventional projection on the normal size screen and the swing over to the CinemaScope field which, because of the much greater area to be covered, cut down the screen illumination almost 50%. In order to compensate for this we provided a neutral-density filter in the projection lens system to be used during the first half of the film in which normal photography was being used. At the cued point in the picture when the swing over to CinemaScope was achieved, the neutral density filter was removed at the same time as the anamorphic lens was swung into place. This gave the same field illumination for both segments of the film.

The use of this medium is most effective and far reaching. Unfortunately, it can only be used for specific, limited showings such as those described here. It is doubtful whether the time will ever come when wide-screen 16mm projection will be available throughout the nontheatrical field, and each application will present its own screening problems, but for effectiveness and an outstanding way to present a product CinemaScope gives the most dramatic and telling results.

Stock Film Cataloging

By LEWIS H. HUMPHREY

Because of the need of an extensive stock film library, Moody Institute of Science has developed a very effective classification and cataloging system. Modeled after the Dewey Decimal System used by public libraries, this system enables a cataloger to group similar material and make it readily available to film editors with a minimum of effort.

Any producer who makes a great use of stock shots realizes the value of being able, not only to know what is available in his film library, but also to locate easily the scene he is looking for. Since Moody Institute of Science uses a good deal of nature footage accumulated over years of shooting, it has developed a very effective method of classifying and cataloging its footage in a film library patterned after that used by most school and public libraries for books. There are several methods currently used by film producers to catalog footage, but in some of them the system is so tied up with a personality, that were that person to become unavailable the system would collapse. We believe that the method we outline in this paper is flexible enough to include the smallest or the largest operation over any period of time and will make material as readily available years hence as it is when first produced.

Caption Sheet

A cameraman's caption sheet is very necessary to a cataloger, especially with certain types of footage such as photomicrography, etc. This sheet (Fig. 1) is filled out by the cameraman at the time the footage is shot and sent in with the film. The caption sheet not only gives a scene by scene description of the footage, but also gives other pertinent information useful in cataloging the material. These sheets are serially numbered and filed by this number as a permanent record as to cameraman, camera, location, etc.

Classification

The next step is that of classification. This is a most important step and the one that usually gives the most trouble. What is done at this point determines whether or not a person unfamiliar with the footage available in the library can find it. All public libraries have a "classification index." This index determines where on the shelves a certain book goes. The same is true in film cataloging. The classification determines in what roll, in what can, and on what shelf the particular scene is to be filed. To do this we have chosen a main classification division as shown in Table I. Each main division is likewise subdivided as shown by the sample in Table II. Each subdivision can be further subdivided as shown by the sample in Table III. You will note that as we subdivide we expand the number categories to the right of the significant figures. But this expansion is not limited as we can pass beyond the decimal point as shown in Table IV. If necessary this can be further expanded by adding as many decimal places as necessary. How far to expand the classification must be determined by the cataloger. Obviously, everything could be classified under one of the main headings in Table

TABLE I

000–GENERAL
100–Promotional
200–Missionary
300–Teaching
400–Scenics
500–Science & Technology
600–History, Geography, Travel
700
800–Television Productions
900

TABLE II

400–SCENICS
10–Sky
20–Land
30–Water
40–Marine
50–Winter
60–Wild Life
70–Floral
80
90

TABLE III

420–LAND
1.–Mountain
2.–Hill
3.–Prairie
4.–Desert
5.–Jungle
6.–Rural (Farm)
7.–Urban (City)
8.–Buildings
9.–Misc.

TABLE IV

428–BUILDINGS
.1–Government
.2–Historic
.3–Old West
.4–Sports

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I, but this would not give enough differentiation. It would also be possible to go to such extremes the other way that the cost of cataloging would overbalance the advantages gained by this intricate subdivision. Obviously the logical place is in between these extremes and that must be determined by the use that will be made of the system.

Subject Heading

In addition to a classification index a list of subject headings is important. This cannot be set up before hand but must be developed by a process of accumulation as cataloging progresses. The advantage of such a list is the aiding of the cataloger always to classify a similar subject the same way using the same subject headings. For example, scenes of Sea Elephants could be classified as Sea Elephant, Elephant Seals, or Seals, Elephant. The last is the proper subject heading and the list would show after the first two headings the term "see, Seals, Elephant." Subject headings should be chosen to seem logical and apt to be the term most likely thought of by the average person. If footage is classified by a subject unfamiliar to most people, then it is unlikely that the footage would ever be used because of the difficulty in finding it in the card index.

Card Index

The next step is the making of the cards for the card index. We found it advisable to have special cards printed (Fig. 2). This form is printed in quadruplicate interleaved with one-time carbon and stapled together so as to be easily used in a typewriter (Fig. 3). From the film and the accompanying caption sheet, the edge numbers, subject, description and other information are typed on the card. Each card represents one scene, or a group of scenes if all are very similar. The cards are separated and one or two cards are filed under the "Subject Index" by subject. When a card has two subjects, the white card is filed under the first or primary subject and the yellow card under the secondary subject. If more subjects are involved, additional cards can be made. Sufficient cross-reference cards should be used to take care of the approaching of a subject from different angles. The green card is filed numerically under the Edge Number Index by the edge number listed. This will enable the original footage to be found if this number is printed through when the work print is made. By making a sequence list according to edge numbers of the scenes in the completed work print picture the job of pulling the original is simplified. One goes to the edge number file and notes from the cards the can and roll number where each scene is located: the job of finding the original is now reduced merely to pulling the indicated rolls and running down and by

CAPTION SHEET — Nº 1834

MOODY INSTITUTE OF SCIENCE — Los Angeles 25 — DATE 2/10/55

PHOTOGRAPHER: Rudy Labbé — TEMP. ROLL NO. 144 — FILM Type "A"

SUBJECT: Molds & Fungi — PROJECT NO. 15 — CAMERA NO. Parke 1

LOCATION: Studio — MAGAZINE NO.

TAKE'S FOOTAGE	DESCRIPTION OF SEQUENCES	ROLL NO.	KEY NUMBERS
Slate			
1 } 5 ft.	Orange slab-mold - f11; No Ext. tube		
2 }	" " " - f8; " " "		
3 } 5 ft.	" " " - f11; ½" " "		
4 }	" " " - f8; ½" " "		
5 } 10 ft	End angle of above - f11; ½ " "		
6 }	" " " " - f8; ½ " "		
7 } 5 ft.	Green slime mold - f11; ½ " "		
8 }	" " " - f6.3; 1½ " "		
9 } 10 ft.	" " " - f11; No ext. (long)		
10 }	" " " - f8; ½" " (close)		
11 } 10 ft	Yellow puff ball - f11; no ext. (med)		
12 }	" " " (- f8; ½" " (spores going)		
13 } 5 ft	N.G. TAKE wrong f setting —		
14 }	Yellow puff ball - f11; no ext. (group)		
15 } 3 ft	Brd. spore of puff ball - f8.0; 1" ext.		
16 } 12 ft	Common "toadstool" f11 - NO EXT. (group		
17 }	" "		
18 } 10 ft	" " " - " " (med.)		
19 }	" " " " " (close)		
20 } 8 ft	" " f11 - ½" ext. (under cap)		
21 }	" " f8 - " " " "		
22 } 10 ft.	" " f11 - no ext. (group)		
23 }	" " " " (group - low)		

Fig. 1. Photographer's caption sheet.

the edge number finding the exact scene required. The fourth, or pink card can be filed by subject in a separate file to be used later by the editor in preliminary editing. By shuffling the cards in story form order, the first or rough cut can be materially speeded up.

Processing

The final step we will call "processing" to be differentiated from the usual meaning of the term. It consists of labeling the actual footage. As subjects are photographed, the original is divided according to the classification decided upon. Each roll is rolled with heads out and the classification number and roll number on the leader. The subject can also be listed to more easily identify the contents. Thus a roll might read 571.4-3 "Squirrels." 571.4 is the class while -3 represents the third roll of this class. This would then be placed in a can which would be labeled 571.4 and occupy a place in the vault corresponding to that classification number. We have found it best to limit the size of rolls to 400 ft of 16mm making it possible to put six rolls in a 2000-ft 35mm can for storing.

Conclusion

Not only is this system useful in cataloging original motion-picture material, but it can also be used for cataloging "viewing" prints of the original material, and with some revisions is very adequate for cataloging and filing still material, both black-and-white and color. Although this system necessitates a bit more work at the beginning, we feel it more than pays for itself later on when memories become dimmed and deadlines are staring one in the face and that particular bit of footage is a "must" to finish off a production.

References

Dewey Decimal Classification, Forest Press Inc., Lake Placid Club, Essex Co., N.Y.

Sears List of Subject Headings for Small Libraries, H. W. Wilson Co., N.Y.

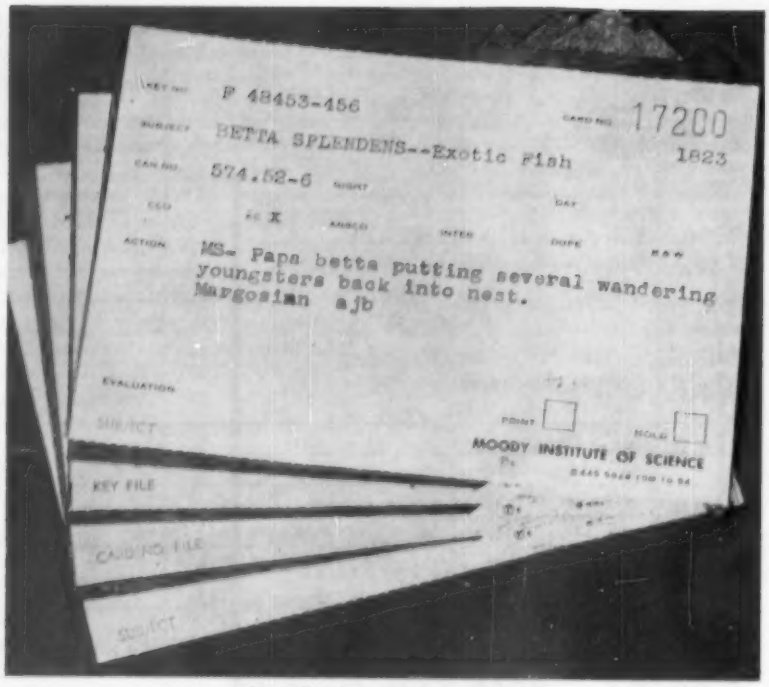

Fig. 2. Catalog cards for card index.

Fig. 3. Method of typing index cards.

Discussion

Richard Polister (Purdue University): Are the takes spliced together in those 400-ft reels?

M. Humphrey: We, at Moody Institute of Science, try to shy away from tape as much as possible. It has some very disastrous results at times. So we splice all of our takes together. We do that because we sometimes have to view our original.

Mr. Polister: Do you use the original on a viewer or a projector?

Mr. Humphrey: We have one pro ector we use. It's an old model Eastman Kodascope with the pressure of the gate relieved slightly. We find that it does not scratch film and it's about the only one we have been able to use with that result.

Reid H. Ray (Reid H. Ray Film Industries, Inc.): On your index card do you designate what type of film it is?

Mr. Humphrey: So far we have shot only on Kodachrome, either Kodachrome Commercial or type A and regular and, normally, that information is put on.

Malcolm Fleming (Indiana University): Do you have any provision for reuse of your original? That is, when you want to use a scene, do you pull it out, cut it into a production and leave it there, or do you work from a master or duplicate with your color and leave your original intact?

Mr. Humphrey: We usually pull our original scenes out and use them in the first production in which they occur. True, we at Moody Institute of Science, print mainly from masters although we do make some of our prints from the original. If we have to use that original and it is in another production, which often is the case, if we can't use a master, then we will pull that particular scene out and replace it by leader so that we can put it back in again, for another printing.

Mr. Fleming: There again your file system provides the necessary information that you have such footage. If it is used in another show, you can go dig it out.

Mr. Humphrey: Yes, when this particular footage is used we stamp on its card the name of the production. The card goes back in the file. In going through later, coming across this card, you see that it is in a certain production and you know then where to find it.

A Survey of the Distribution of Nontheatrical Motion Pictures

By HERBERT E. FARMER

Between the production of a motion picture and its showing lies the essential step of distribution or circulation by which the potential user learns of its availability and acquires it for his use. This paper briefly reviews the history and growth of the field of film distribution; analyzes the various channels and procedures used today by film distribution agencies; and surveys representative distributors, libraries and user groups, correlating the business and fiscal policies under which subjects are acquired and circulated.

After a motion picture is made, a number of things must be accomplished before it can be seen by an audience. For the nontheatrical film, the user must become aware of its existence and availability, prints must be put in the hands of agencies who will circulate it, and the user must take the initiative to procure it. Taken together, these procedures which intervene between production and use are labeled distribution, and are, or should be, a matter of vital concern to both producers and users of motion pictures. The educational efficiency, psychological value and financial success are proportionate to the effectiveness of the distribution process.

Over the years, the theatrical motion-picture industry has developed a comparatively straightforward distribution system which seems to serve its needs. The patterns of distribution of nontheatrical films, however, are much less clearly defined. This is due, of course, to the greater variation in subject matter and purpose, and to the differences in the interests, financial resources and composition of the audiences for which they are intended.

In the discussion that follows, *distribution* will be considered as the totality of activities that occur between production and viewing by an audience. The term *distributor* will refer to a company or individual representing the producer

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in all negotiations relating to the sale of copies, serving a function roughly comparable to that of the wholesaler in the merchandising field. The term *film library* will refer to the individual or organization having direct contact with the user. These categories may be represented by companies and persons who perform each function separately, or they may be combined.

Important as this subject is to everyone connected with the industry, comparatively little has been written about it. What has been written appears to relate more to the use of films for specific purposes, such as education or industry, or to problems of specific groups such as public libraries or the armed forces.

The History of Film Distribution

In the early days of the motion picture, just before the turn of the century, film distribution was very simple. Each film was a short, separate entity three minutes in length, and was available only by outright purchase.

For several years, exhibitors bought films for themselves until investments became so heavy and their collections of films so large that the custom of exchanging films among themselves arose. In 1903, the Miles Brothers' Exchange was founded, buying films from the manufacturers and renting them to exhibitors.

Education and industry started using films in the early 1900's but the first genuine nontheatrical film library seems to be that of the Young Men's Christian Association formed in 1911. The nontheatrical film did not really come into its own, however, until about 1923 when major manufacturers agreed on the 16mm film width as standard, and suitable projection equipment and a satisfactory safety film base were developed. After these essentially *mechanical* barriers were overcome, nothing stood in the way except the resistance to these new methods and ideas of many people in industry, education, religion and, in fact, all fields.

The entire history has been exciting and stormy at times. The ten years preceding World War II saw the growth and development of some of the major large commercial film libraries. It is generally accepted, however, that the nontheatrical film made its greatest strides during World War II, when all branches of the armed services made extensive use of films for training and psychological conditioning of both service and civilian personnel. It was during this period that much concrete evidence was obtained concerning the possibilities of the medium and many people, previously unaware of the potentialities, became staunch supporters.

Following the war, production and distribution activities continue to grow. Many of the major nontheatrical producers have found it desirable to maintain, as a part of their own organization, a distribution or "sales facility" to insure the use of their product. Many have even purchased or affiliated with rental film libraries to make their titles available to the occasional user whose needs do not warrant the purchase of a film.

In the period immediately following World War II, a number of entirely new channels of distribution began to develop. Films began to find an important place in public libraries and museums. Although the American Library Association began to think about visual materials as early as 1924, it was not until 1947 that films were added to their list of more traditional materials.

With the rapid expansion of the use of nontheatrical motion pictures and the frequent changes in technology, it is little wonder that, to the average user of films, the distribution situation appears somewhat chaotic.

The Film's Audience

In the nontheatrical film field the type or pattern of distribution must, of necessity, be geared to reach a specific audience and to accomplish some specific objective.

The conventional way of grouping nontheatrical audiences is in terms of their interests: for example, education, industry or religion. Within these, however, are three basic divisions which generally apply:

1. Organized groups — many interest groups have local, national and international committees, councils, or staffs, either voluntary or paid who are correlating film activities within their field (e.g., education or medicine).

2. Unorganized groups — other interest groups make use of films in a less systematic way and rely almost entirely on the resourcefulness of individual members for such films as fit their programs (e.g., Rotary Clubs).

3. Individual users — many individuals make use of films for personal home or family showings. A few years ago, this group was thought to be commercially significant and some distribution activities were directed toward filling this need on a low-cost, mass-production basis. It now appears that this need has been filled largely by television.

The current trend seems to be toward more organized groups which are doing much to locate, promote and make available information and materials to further their interests.

Under one philosophy, television might be considered as a purveyor or transmitter of visual material, a specialized type of distributor. It is probably more correct to think of it as an agent, representing the millions of individual home viewers who look at programs in small groups and who choose their fare on the basis of personal interest.

The Film's Objective

All films have as a purpose at least one of the following:

1. Entertainment,
2. Understanding of problems or situations,
3. Motivation to action, and
4. Instruction in subjects or skills.

It is obvious that many films have more than one objective. In general, it may be said that the primary purpose of the theatrical film is entertainment and that of nontheatrical films are primarily to increase the understanding of problems, to motivate people into action, or to teach certain basic skills.

If we accept the premise that nontheatrical films are primarily tools of communications, it must be recognized that they will do certain jobs better than others and that each film must be evaluated in these terms and its distribution planned to that end.

The effectiveness of any film depends, first on how well the intended audience is defined and second, how sharply the film is aimed at this group. The *procedures* of distribution determine whether or not it achieves its objective.

Patterns of Distribution

When the films available to any group are considered, it soon becomes apparent that an almost identical pattern of distribution exists in each area, at least from the economic point of view.

1. There are those films for which the users are expected to pay eventually for all the costs of production and distribution. These films may be found in rental libraries where a direct charge is made each time the film goes out or they may be the so-called "free library" where the user actually contributes *indirectly* to the costs through public funds used to support public libraries or public school systems.

2. There is a second type of distribution in which a part of the costs, usually those for production, are underwritten but where the user is expected to pay a service charge for the use of the film to cover the costs of distribution.

3. Finally, there is sponsored distribution with a company or agency paying all the costs, expecting its return in the form of advertising or improved employee or customer relations. While these films are free to the user, they should not be confused with the films from "free libraries."

Film Distributors

Within the scope of this paper it is best to consider the film distributors as the sales representative of the producers.

Their responsibilities are essentially the promotion and selling of films.

Some of the distributors in the field today are also producers of films. A few of these have their own production organizations with studios and complete facilities. Others do not engage in actual production, but contract with producers to make films from scripts which they have prepared. Still others deal only with films made by other organizations and handle all of the problems and responsibilities involved in promoting and marketing these films.

The policies of the film distributors are anything but stereotyped and uniform. They range from very large organizations with a number of branch offices and sizable sales forces, to small one-man operations. There are, however, four basic sales plans in general use:

1. Direct sales through the companies' own selling channels, branch offices and salesmen.
2. Sales through dealers, where the distributor supplies preview copies and stocks the sale prints, and where the dealer "promotes" sales and handles the orders.
3. Straight dealer selling where the dealer buys copies from the distributor handles his own previews and other sales problems and carries a local inventory of release prints.
4. Direct mail sales where all business is handled largely by correspondence.

Each of the above systems has its advantages and disadvantages.

In the cases where the producer is also the distributor of the film, there is little problem of division of financial returns. The problem becomes more complex, however, in the cases where a distributor handles the films of other producers. The financial terms are usually covered by a contract or memorandum of understanding which establishes, among other things, the percentage or consideration to be remitted to the producer. These range from as low as 5% of the gross return to as much as 50% with the average between 10 and 20% depending on such factors as probable sales, cost of distribution, cost of prints, etc.

Although the distributor sells copies of the films, they usually retain the television rights on all such sales and handle the television distribution directly from their home offices. The rentals charged are considerably higher and are usually proportional to the listener potential of each station. The yardstick which is often used is the Class A time rate for the station. Usually distribution contracts provide for the producer to share in the rentals for television usage.

The great majority of films sold by distributors are sales to film libraries which in turn make them available to the ultimate users.

Film Libraries

The Film Council of America reported in 1950 in *The Film Councilor* that, according to a survey conducted by them:

1. Not enough copies of the films were currently available.
2. What copies there were, were not equitably distributed throughout the country geographically.
3. More than three-quarters of them were in libraries serving groups such as public schools which could not make them generally available.

Since that time there is no question that the number of films and film libraries has increased but it is certain that the demand is far from satisfied.

In 1953, the U.S. Office of Education published the pamphlet *A Directory of 2,660 16mm Film Libraries* which gives some indication of the scope and number of organizations engaged in making films available. Generally speaking, these are divided into two groups:

1. National libraries which include those organizations having branch offices in the major cities as well as the large single libraries which serve the entire country from one primary location.
2. Local libraries which encompass the many purely regional libraries such as school systems, public libraries, universities and industrial concerns. This group also contains the commercial libraries which serve a local area, and the agencies of the federal government which have films available.

Although a detailed comparison of the policies and characteristics of the many various types is both interesting and revealing, it is beyond the scope of this paper.

Problems of Film Sales and Circulation

The essence of film distribution may be said to be the many physical procedures and operational problems which make up the business.

This author has chosen to divide the physical problems of film circulation into five basic categories:

1. Procurement of product,
2. Promotion,
3. Evaluation and selection,
4. Library records, and
5. Film handling problems.

In procuring the rights to distribute a film, the terms should be covered by appropriate legal documents, all parties should be satisfied that proper clearances and releases have been executed and geographical limitations and time limits should be set forth. It is wise to establish sales and rental prices and policies for all types of usage including television.

As a part of its promotion, the distributor should see that the subject is properly listed in the usual reference sources as well as in the specialized publications which will bring it to the attention of those who will find it useful or interesting. Mailing pieces and study guides must be prepared and circulated widely, preferably to the specialized mailing lists which the distributor should maintain.

One of the greatest problems of promotion which faces the distributor is previews. Before a potential buyer will place his order, he has come to expect the privilege of looking at the film and prints for this purpose must be made available.

Libraries and users have the sizable task of evaluating and selecting the films which will be most useful to them and deciding which to buy. This often becomes a difficult problem as there is seldom enough money to buy all the films which would be useful.

Obviously, efficient records and procedures are essential if the library or distributor is to gain a reputation for promptness without confusion. Booking cards, the calendar on which the basic information is recorded, the booking confirmations, invoices and shipping records are all a part of the paper work involved. A number of large libraries have found it helpful, if not essential, to use business machine methods of handling the volume of records and data.

Last, but by no means least, the problems of physical handling must be carefully considered. Film storage, filing, shipping and receiving, inspections and cleaning are all a part of the library's responsibility for which space, personnel and equipment must be provided.

Conclusion

The nontheatrical film distribution industry has grown constantly for nearly fifty years and there is every reason to believe that the trend will continue. If the patterns seem somewhat confused, this is probably due to the many purposes and varied groups which these films serve.

Up to this time, the distribution of nontheatrical films has been predicated on a fairly limited market but in practically no areas can it be said to be saturated. Instead of an average sale of three or four hundred copies of a film as is the case today, it seems entirely possible that three or four thousand copies might more adequately begin to serve the existing needs. Before this becomes a reality, however, it is obvious that changes in technology and marketing practices must come about.

Arc Lamps for 16mm Projectors

By ROBERT S. FREEMAN

The use of arc lamps with 16mm projection equipment can extend the screen size, permit projection in rooms that cannot be entirely darkened, and allow greater picture detail to be observed due to the higher screen brightness. The various arc lamps and their associated power supplies are briefly described.

With the use of 16mm projection equipment for the showing of motion pictures to large audiences the need for increased light is becoming more apparent.

That it is possible to show 16mm pictures to a large audience was demonstrated recently by the premiere of a new educational film in Madison Square Garden. A full color film was projected more than 250 ft onto a screen 32 ft wide in the main arena of the Garden.

When the size of the audience exceeds 200 people a screen larger than 8 or 9 ft wide should be used. An incandescent lamp will not furnish enough light for this size of screen and an arc lamp should be used.[1]

Portable 16mm 30-amp arc projectors are capable of projecting 1600 lm onto the screen using a two-interruption shutter with approximately 70% center-to-side screen distribution. This is approximately five times the amount of light obtained with a 1000-w incandescent lamp.

An arc lamp which projects 1600 lm on the screen will allow a picture 15 ft wide to be used on a matte-surface screen and provide 9 ft-L when measured at the center. A 15-ft wide screen is large enough for an audience of approximately 575 people.[2]

The larger semiportable 16mm 46-amp arc projectors are capable of producing 2500 lm on the screen, with the shutter running. With 2500 lm available a picture 18½ ft wide can be used with a brightness of 9 ft-L on a matte-surface screen. This is large enough for an audience of over 1000 people.

Carbon-Arc Lamp

Basically there are three carbon arcs which are used for 16mm projection. These are the 10-amp, 30-amp, and the 46-amp arcs.

Portable 10-Amp and 30-Amp Arcs. The 10-amp arc is a relatively new carbon-arc trim available on the RCA Porto-Arc projector when special feed and take-up facilities are provided. The carbons used are a 6.4-mm carbon for the positive and a 5-mm carbon for the negative. These carbons will allow a continuous showing of a 4000-ft reel of film which takes approximately 2¼ hr.

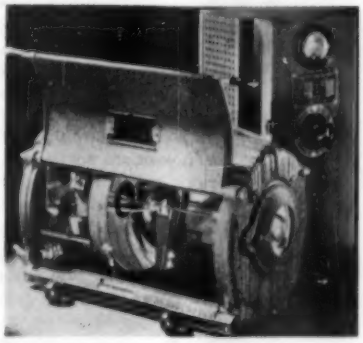

Fig. 1. 30-amp reflector-type arc lamp used on the Amproarc 20, GPL PB101, and Holmes Nuarc, Rexarc, and Television Rear Projector.

The 10-amp trim will project 850 lm on the screen at 70% center-to-side screen distribution using a two-interruption shutter. This is over twice the amount of light obtained with a 1000-w incandescent bulb.

The power supply which is used with this carbon trim provides 10 amp d-c at 50 v. Two 6-amp gas-filled rectifier tubes are used. Primary tap switches are provided for varying line voltages.

The 30-amp 28-v d-c arc uses a 6-mm × 8½ in. positive carbon and a 5½-mm × 6 in. negative carbon. These carbons are sold under the National Carbon Co. trade name of Pearlex. With the lamp operating at rated voltage and current, the burning rates of the carbons are 6¼ in./hr for the positive carbon and 3⅜ in./hr for the negative carbon. This will allow the continuous showing of a 2000-ft reel which takes approximately 1 hr.

There are two types of lamphouses used with the 10- and 30-amp arcs. They are the reflector type and the reflector-condenser type. Figures 1 and 2 show these lamphouses.

The reflector type of arc lamp is used on the Amproarc 20 projector, the General Precision Laboratory Model PB101 projector, and on the Holmes Nuarc, Rexarc and Television Rear Projector.

This arc lamp uses an elliptical reflector 10¼ in. in diameter with a geometric focus of 4 in. The working distance of the reflector is 16 in. from the film aperture which results in an optical speed of $f/1.6$. This matches the $f/1.6$ lens commonly used in 16mm projectors.

The reflector-condenser type of arc lamp is used on the RCA Porto-Arc projector[3] and on the Victor 1600 projector. This arc lamp uses an elliptical reflector 7½ in. in diameter at a working distance of from 24 to 25 in. The condenser lens is mounted 13 in. from the reflector and the combination of the reflector and condenser lens results in a working distance of less than 17 in. This will give an optical speed of approximately $f/1.6$.

Some of the features which can be found on the lamphouses for portable projectors are horizontal and vertical adjustments for the reflector, focus adjustments for the reflector, adjustable-speed motor for carbon feed, arc imager and an ammeter to read the arc current.

All the projectors require heat filters or aperture cooling when black-and-white film is used unless it is of a rather low density. Usually the heat filter is not required when showing color film. At silent speed (16 frames/sec) the heat filter is required for all film.

Power supplies for the 30-amp arc are two-tube, gas-filled, full-wave rectifiers. They operate off a 115-v line and have line adjustment taps for voltage variations. The a-c load does not exceed the 15-amp limit provided for by most 115-v convenience outlets. A-c voltmeters are provided on the rectifiers to check the line voltage. All the lamphouses have an interlock switch which operates a contactor to remove power from the arc whenever the lamphouse door is opened.

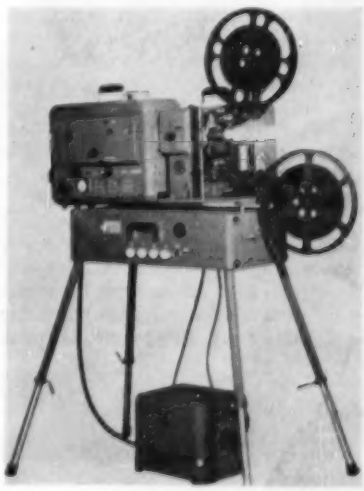

Fig. 2. Reflector-condenser type arc lamp as used on the RCA Porto-Arc Projector.

Presented on April 19, 1955, at the Society's Convention at Chicago by Robert S. Freeman, Strong Electric Corp., 87 City Park Ave., Toledo 2, Ohio.
(This paper was received on April 19, 1955.)

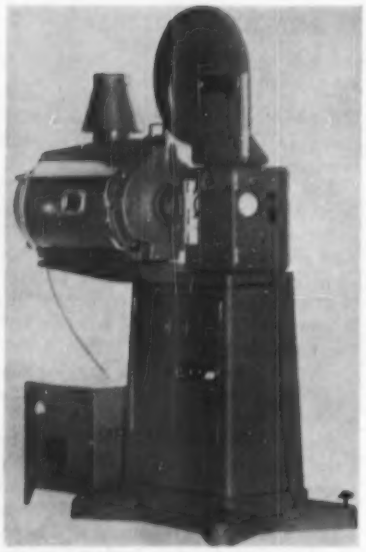

Fig. 3. 46-amp arc lamp used on the General Precision Laboratory Model PB 102 Projector.

Semiportable 46-Amp Arcs. A 46-amp 33-v d-c arc lamp is used on the General Precision Laboratory Model PB102 projector and on the Eastman Model 25 projector. These projectors are semiportable, however they are extensively used where a permanent installation is desired. Figures 3 and 4 show these lamps mounted on projectors.

The carbon trims used in these lamps are a 7-mm × 12-in. Suprex positive carbon and a 6-mm × 9-in. Orotip C negative carbon. These carbons will give a full 80 min of burn at 44 to 46 amp and 33 v d-c.

The reflector used in the lamp is $11\frac{3}{8}$ in. in diameter with a geometric focus at 4 in. and a working distance at 30 in.

The lamp used on the GPL Model PB102 projector has a plano-convex lens of approximately 15-in. focal length placed $3\frac{1}{8}$ in. from the film aperture. This allows the reflector to work at $25\frac{1}{2}$ in. with a beam speed at the aperture of $f/1.6$. The plano-convex lens acts also as a heat filter. In addition to the heat filter the GPL Model PB102 uses a pulsed air blast on the film aperture to cool the film and reduce film buckle.[4]

A condenser-lens system is also used with the Eastman lamp.[5] The condenser lens, which is used on the projector with a tungsten lamp, is replaced by a condenser lens of 44-mm (1.73 in.) diameter designed for use with the arc lamp. A heat filter 5 in. in diameter is mounted directly in front of the lamphouse. The heat filter is required for black-and-white film but is not required for color film. To reduce film buckle a curved gate of 3-in. radius is used. This slight curvature of the film gives it strength to withstand the distorting forces produced by the heat on the film.

The 46-amp arc lamp is capable of supplying 2000 to 2500 lm on the screen depending upon whether or not a heat filter is used.

The rectifier for this lamp is a 230-v, 4-tube Tungar rectifier. The current drawn on the primary side of the transformer at rated output voltage and current is 13 amp. Power to the arc may be adjusted by an 8-position rotary-dial switch. An interlock switch is provided on the lamphouse door which operates a mercury relay to control the a-c power input to the rectifier. Also included on the rectifier are an a-c voltmeter and line-voltage adjustment taps.

Xenon-Arc Lamp

A new type of light source which has been developed for use on 16mm projectors is the xenon-arc lamp.

Fundamentally the xenon compact arc lamp is an electric arc in a confined xenon-gas medium between two closely spaced electrodes.[6]

The first man to make a compact xenon-arc lamp appears to be Paul Schulz in Germany. In 1951 work was begun by the Hanovia Chemical and Manufacturing Co. of Newark, N.J., on the feasibility of using a xenon-arc lamp for the 16mm projector used by the Navy. In February of 1953 the DeVry Corp. of Chicago was awarded a contract to adapt the xenon-arc lamp to the Navy AQ-2(1) projector.[7]

Some features of the xenon compact arc are[8]:

(1) A compact optical system can be designed since the xenon-arc lamp is an enclosed bulb.

(2) The light from the arc can be pulsed so that no shutter is required on the projector. Power is consumed by the arc only when the light is being used on the screen.

(3) The arc requires no more attention than an incandescent lamp and will operate for any length of reel.

To strike the arc automatically and obtain a pulsed light output a ballast and starter are required. The ballast package which is a separate unit consists of a striking and ballast transformer,

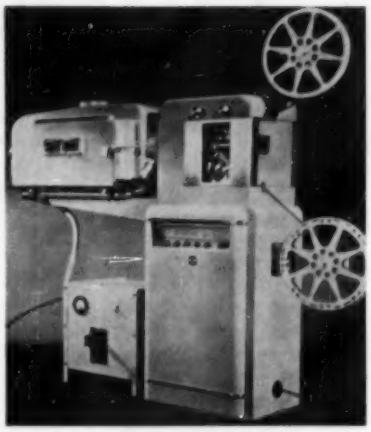

Fig. 4. 46-amp arc lamp used on the Eastman Kodak Model 25 Projector.

peaking transformer, striking condenser, line contactor and high-voltage transformer for the pulse coil.

The starter components are the pulse transformer, capacitor and spark gap. When the lamphouse door is opened a line contactor in the ballast will be de-energized, thereby removing all high voltage.

The xenon lamp and striking circuit require 150 v, 900 va at strike. After establishment of the arc the arc will burn at 30 v and 30 amp a-c.

This lamp as used on the Navy AQ-2(1) projector is capable of projecting 2000 lm on the screen with a center-to-side screen distribution of 75%.

The reported life of the arc bulb is in excess of 300 hr.

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Effect of Nitrogen Oxide Gases on Processed Acetate Film

By J. F. CARROLL
and JOHN M. CALHOUN

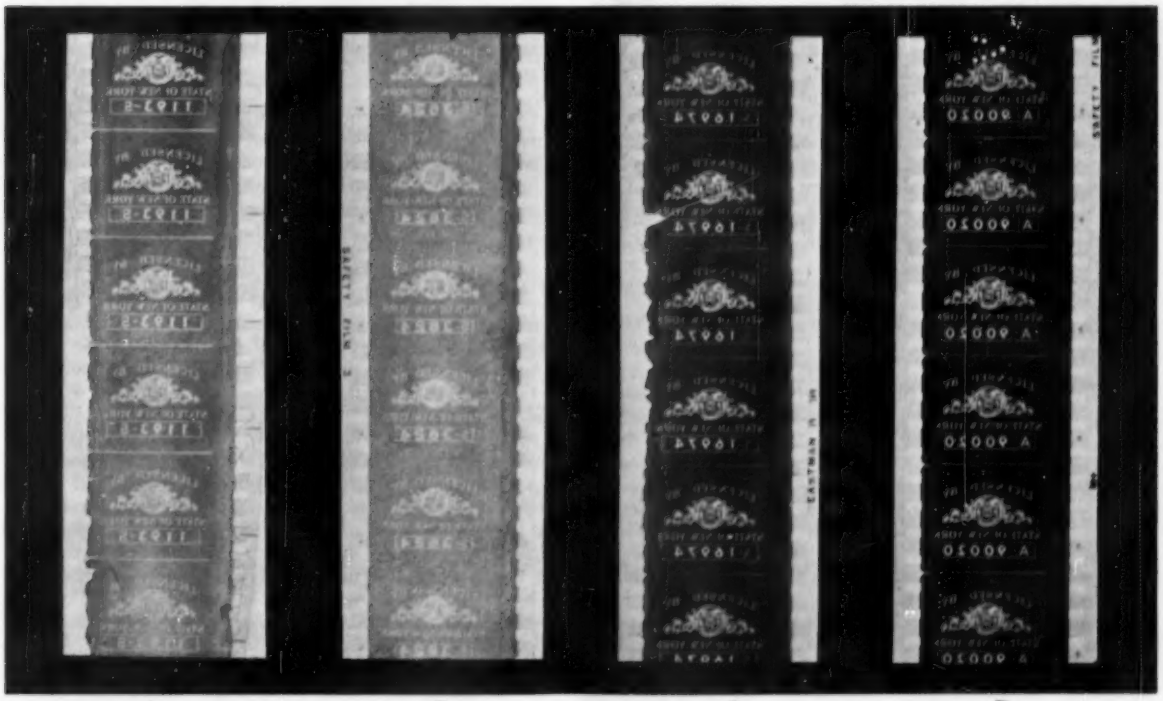
Safety motion-picture film on cellulose acetate base has been found chemically damaged on occasion by storage in the same can with unstable nitrate film. As a result, the effects on acetate film of the three nitrogen oxide gases produced by the decomposition of nitrate film have been investigated. Nitrous oxide and nitric oxide were found to be harmless, but nitrogen dioxide, even at low concentrations, is seriously damaging to safety film. This is to be expected, since nitrogen dioxide reacts with moisture to form nitrous and nitric acids. The order in which the film components are attacked by nitrogen dioxide is: the silver or dye image first, the gelatin of the emulsion second, and the acetate base last. The rate of attack increases with increase in relative humidity. It is concluded that safety films should never be stored in the same can with nitrate films and preferably not in the same room.

THE CONVERSION from nitrate film to cellulose triacetate safety film in the United States in recent years has greatly simplified the problem of preserving valuable motion-picture films. The high stability and permanence of acetate film compared to the tendency of nitrate film to decompose slowly with age even at room temperature, is well known.[1,2] Since the stability of acetate film was investigated by Hill and Weber[1] it has been improved in flexibility and other properties and, as long as it is stored by itself under moderate climatic conditions, it is an extremely stable material. However, cases have occurred where acetate films stored in the same can with nitrate films have been seriously damaged when the latter began to decompose. This damage took the form of fading and discoloring of silver images, softening of the emulsion, and degrading of the acetate base (Fig. 1).

That unstable nitrate film does, in fact, cause damage to safety film was confirmed by interleaving layers of processed safety film between layers of unstable nitrate film in rolls. After five weeks at room conditions it was found that the black-and-white safety film became faded and yellowed and that the color film became badly discolored and bleached (Fig. 2). The present investigation was undertaken to determine which of the nitrate decomposition products damages acetate film and some of the factors involved in the reaction.

The gases that are known to be evolved by the decomposition of nitrate film and could conceivably be deleterious to safety film are the nitrogen oxides: nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2).[3] Both nitrous oxide and nitric oxide are colorless gases and both are sparingly soluble in water, particularly nitric oxide. Nitric oxide reacts instantaneously upon exposure to air to form nitrogen dioxide. Nitrogen dioxide is a dark brownish red gas that is in equilibrium with colorless nitrogen tetroxide (N_2O_4). Nitrogen dioxide is a very powerful oxidizing agent and is very soluble in water, with which it reacts to form a mixture of nitric and nitrous acids. The gas is extremely toxic.

Presented on April 21, 1955, at the Society's Convention at Chicago by J. F. Carroll and John M. Calhoun (who read the paper), Manufacturing Experiments Div., Eastman Kodak Co., 343 State St., Rochester 4, N. Y.
(This paper was received on May 5, 1955.)



A B C D

Fig. 1. Samples of triacetate black-and-white print films ("license seals") from film exchanges: A, 1949; B, 1950; C, 1951 found in cans with unstable nitrate film; D, a comparison sample not stored with nitrate film.

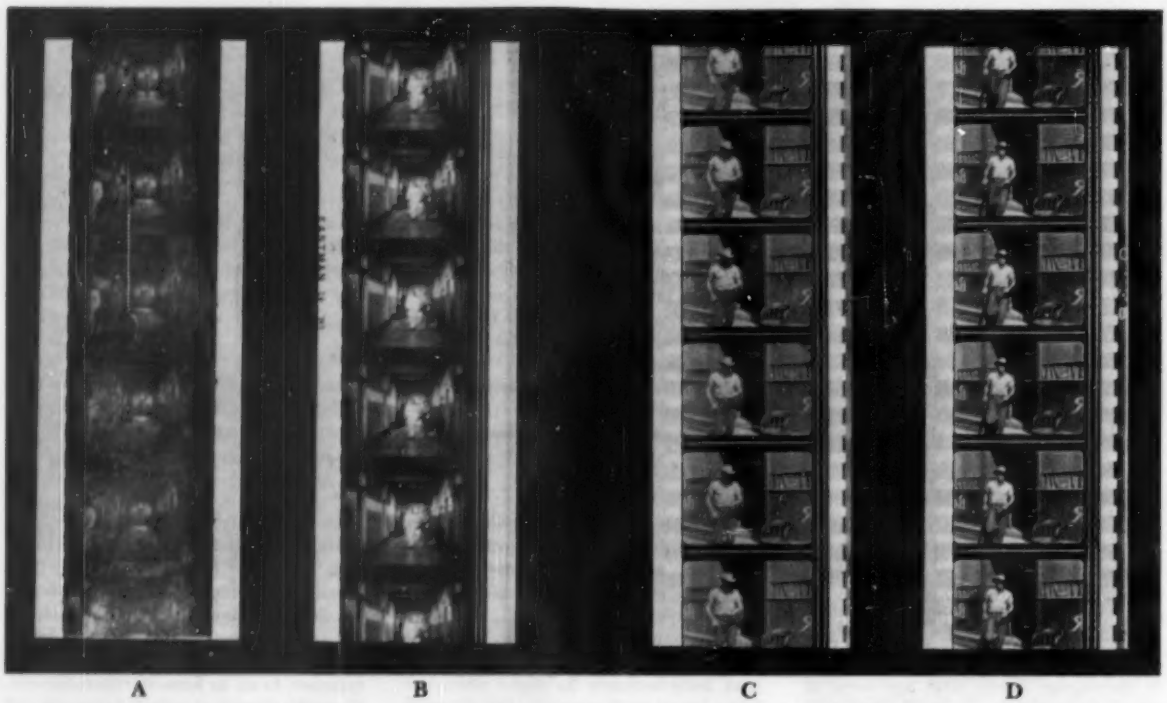


Fig. 2. Examples of safety films damaged by contact with unstable nitrate film: A and B, Eastman Fine Grain Release Positive Film; C and D, Eastman Color Print Film. Samples A and C were wound into a roll of unstable nitrate film for five weeks at room conditions; samples B and D are untreated controls. (Sample C is discolored as well as faded.)

The relative amounts of nitrous oxide, nitric oxide and nitrogen dioxide produced by the decomposition of nitrate film are not known. However, the two latter oxides predominate, which is to be expected since the nitrogen in nitrous oxide is in a lower state of oxidation than in cellulose nitrate. Any nitric oxide will be oxidized rapidly by air to nitrogen dioxide so that the latter is likely to occur most frequently. The presence of nitrogen dioxide in cans of decomposing nitrate film can be detected by odor.

Nitrogen dioxide is known to react with finely divided silver as follows[4]:

$$2\,NO_2 + Ag \rightarrow NO + AgNO_3 \ .$$

Nitrogen dioxide also reacts with water:

$$2\,NO_2 + H_2O \rightarrow HNO_2 + HNO_3$$

Then nitric acid reacts with silver:

$$2\,HNO_3 + 2\,Ag \xrightarrow[H_2O]{} AgNO_3 + AgNO_2 + H_2O$$

The action of nitric acid on silver is greatly accelerated by the presence of nitrous acid, which is formed as shown above.[5,6]

A flow system was designed to treat safety motion-picture film with each of the aforementioned nitrogen oxide gases at various relative humidities. Quantitative measurements were then made of the resultant damage to the silver image, the gelatin of the emulsion, and the acetate support. The effects of these gases on several color films were also observed.

In these experiments a controlled amount of moisture was maintained in the film. When the film was treated with nitrogen dioxide, both nitric and nitrous acids would be formed according to the second of the above equations. No attempt is made to distinguish between these compounds as the active agent. Therefore, wherever reference is made to nitrogen dioxide in the presence of moisture, it should be borne in mind that a portion of the nitrogen will be present in the form of nitric and nitrous acids.

Design and Operation of Apparatus

It is essentially impossible to duplicate the treatment by nitrogen oxide gases that a sample of safety film undergoes when stored with nitrate film in a sealed can and still make quantitative measurements. The reasons for this are that the nitrate film represents a source of continuously liberated gas at an extremely low rate (under normal conditions), and the safety film (present in reasonable quantity) initially contains a relatively good supply of moisture but at a definite relative humidity level. The effective moisture level, of course, changes with absorption of the gases. Therefore, any system attempting to duplicate exactly the actual conditions would have to meter out the gas at an immeasurably low rate over an undesirably long period of time, and would require a large volume of film to be tested in every case, or a means of controlling the equivalent relative humidity of a small quantity of film. In the presence of a gas such as nitrogen dioxide, this latter requirement would be unattainable.

The system selected for treating the safety film samples was designed to give quantitative and reproducible data under well defined conditions that are, admittedly, not identical to the conditions in a film can, but which should be sufficiently close for comparison. Briefly, the procedure consisted of treating safety film that had been conditioned to a definite relative humidity, with a mixture of air at that same humidity and the gas in question in definite proportions. The rate of degradation of the image, the gelatin and the film support were then determined.

Figure 3 is a flow diagram of the apparatus. No device could be found that would measure the extremely low rate of gas flow required and at the same time withstand the corrosive nature of nitrogen dioxide. To overcome this difficulty a gas bubbler (B) was partially filled with Yater and calibrated with air at low bubbling rates (less than 25 bubbles/min). Since nitrogen dioxide is very soluble in water, insoluble nitric oxide was introduced into the bubbler by means of Tygon tubing from cylinder (A). Air of controlled relative humidity was admitted to the rotameter (D), and then the measured air and nitric oxide

were led into a common duct at point (E). Nitric oxide reacts instantly with air to form nitrogen dioxide in the same molecular amount, without any by-products. Since the ratio of air to nitric oxide introduced was greater than 200 to 1, the loss of air in the reaction was negligible. The volume percentage of nitric oxide introduced may be considered numerically equal to the resulting percentage of nitrogen dioxide.

From point (E) where the nitrogen dioxide was generated until the gas leaves chamber (G) where the film was suspended, all-glass connections were used with a minimum of lubricant. The gas could be made to by-pass the film at stopcock (F) during adjustments of gas velocity or flushing. Chamber (G) in which the film was suspended was simply a 500-ml gas wash bottle that was detachable from the system for loading as shown. Rubber connections rather than Tygon were used for this purpose and represented the only exception to all-glass connections in this area.

After leaving the film chamber, the gas was bubbled through a sodium hydroxide solution (K) to remove the nitrogen dioxide because of its toxicity. The air then passed through aspirator (L) which served the dual purpose of providing a driving force for the system and dissolving any traces of nitrogen dioxide not stopped at trap (K). The controllable air intake at (J) provided a means of exactly regulating the pressure in the system with respect to atmospheric pressure, the difference in which was read on water manometer (H). In all of the experiments performed, a vacuum of 2 in. of water was maintained with respect to the atmosphere. Therefore, the maximum variation of bubble size in the bubbler and error in the rotameter corresponds to the maximum variation in atmospheric pressure. The percentage error due to atmospheric variation is much less than the percent atmospheric variation, however, since the bubbler error and rotameter error are partially compensating.

The above flow system was needed only for nitrogen dioxide because of its corrosive properties. Film was tested with nitrous oxide simply by placing the conditioned film in a bottle with the pure gas. In working with nitric oxide, air had to be avoided to prevent oxidation so that a vessel containing the film was filled with illuminating gas to expel the air. This was then displaced by nitric oxide.

I. The Silver Image

Eastman Fine Grain Release Positive Film, Type 5302 (35mm) on triacetate support, exposed to a uniform flash and processed to give a density of 0.835, was used throughout all of the experiments. A sample of this film was left in contact with about 100% nitrous oxide (N_2O) at

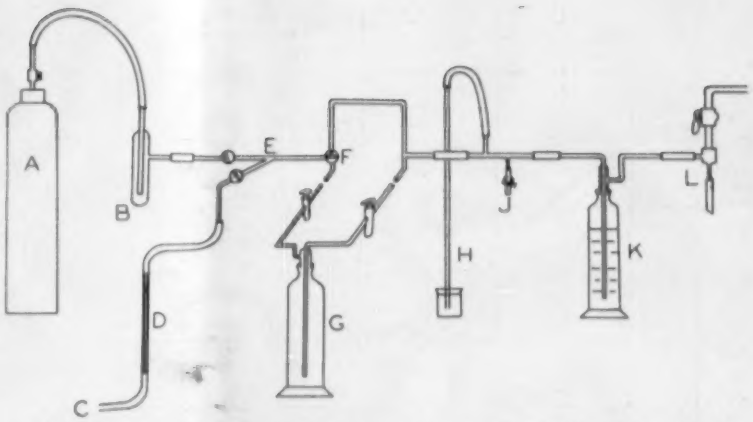


Fig. 3. Flow diagram of apparatus for treating film with nitrogen dioxide: A, nitric oxide cylinder; B, gas bubbler; C, air intake; D, rotameter; E, junction of NO and air to form NO_2; F, three-way stopcock; G, film treating chamber; H, manometer; J, air intake; K, NO_2 trap; L, water aspirator.

100% R.H. for over a week with absolutely no observed effect upon the silver density. Another sample of film was treated for 30 hr with about 100% nitric oxide (NO) at 50% R.H. Nitric oxide is oxidized to nitrogen dioxide (NO_2) instantly in air and, since it was virtually impossible to exclude all air from the conditioned sample, there was a slight initial decrease in density. Aside from this, however, there was no change of density with time. Therefore, it is concluded that although nitric oxide can form nitrogen dioxide as soon as it contacts air, it does not attack the silver image, itself.

Nitrogen dioxide, however, does attack the silver image, even in a low concentration. Figure 4 is a plot of silver density against time for various concentrations of nitrogen dioxide in air initially at 50% R.H. Densities interpolated from Fig. 4 are replotted in Fig. 5 to illustrate the effect of gas concentration for given times of treatment. These indicate that as low a concentration as 0.1% nitrogen dioxide can seriously fade the silver image in less than a day at 75 F.

If the time required to fade the silver image by, say, 0.2 density units, is plotted against nitrogen dioxide concentration on log-log graph paper, a straight line is obtained as in Fig. 6. With some reservation, the straight line in Fig. 6 may be extrapolated to lower concentrations in order to estimate the time required in this range.

Figures 7 and 8 illustrate the profound effect of relative humidity on the rate of fading of the silver image at a constant nitrogen dioxide concentration. This is not surprising since water participates in the reaction between nitrogen dioxide and silver and, in addition, increases the permeability of the film.

It is of interest to consider briefly the physical mechanism of the reaction of nitrogen dioxide (or nitric and nitrous acids formed therefrom) with the silver of the image. The curves of density

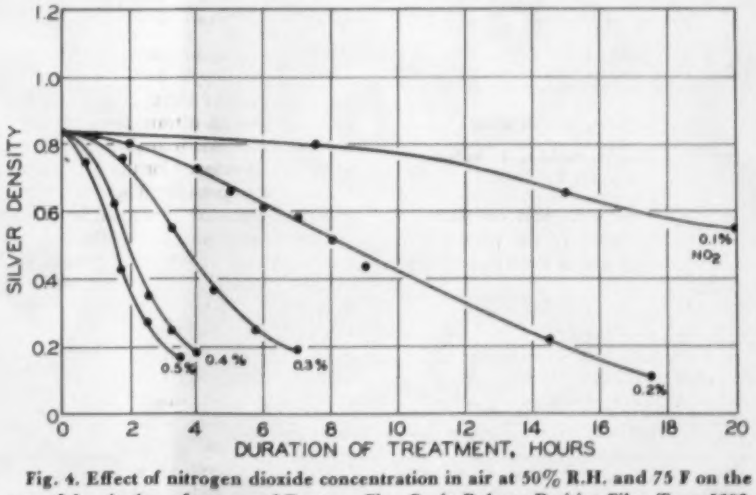


Fig. 4. Effect of nitrogen dioxide concentration in air at 50% R.H. and 75 F on the rate of density loss of processed Eastman Fine Grain Release Positive Film, Type 5302.

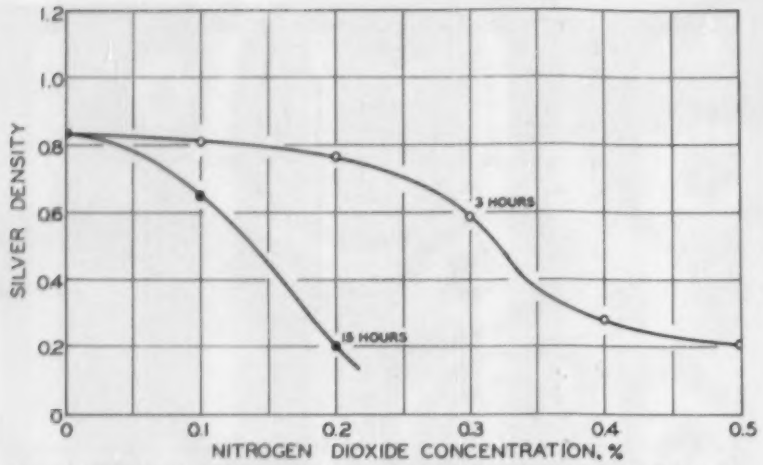


Fig. 5. Relation between nitrogen dioxide concentration and silver density for two times of treatment at 50% R.H. and 75 F (interpolated from Fig. 4).

against time (Fig. 4) can be considered as composed of three parts: an initial slow decrease, then a rapid essentially linear portion in the middle, and finally the reduced slope at the end. Presumably the initial curved portion occurs during the establishment of equilibrium of nitrogen dioxide and water in the emulsion. After this equilibrium is established, the rate of silver disappearance becomes constant, resulting in a straight line. This is because the nitrogen dioxide concentration is maintained constant and the silver is a solid whose concentration must remain constant. The final reduced slope of the curves is the result of a decrease of surface area of the silver after the nitrogen dioxide attack is nearly complete.

Figure 9 is a plot of the rate of density change (which is proportional to the rate of silver loss) against a function of nitrogen dioxide concentration. The slopes of the linear portions of the curves in Fig. 4 were used as the values of rate of density change. The apparent order of this reaction with respect to nitrogen dioxide alone was solved graphically and found to be 2.5. Therefore, the abscissa of Fig. 9 is nitrogen dioxide concentration raised to the 2.5 power. Figure 9 is linear below 0.4% nitrogen dioxide. Above that concentration the silver is presumably attacked faster than the nitrogen dioxide can diffuse through the gelatin, and the diffusion rate becomes a new rate-limiting factor.

II. The Gelatin Emulsion Vehicle

In addition to the silver image, the nitrogen dioxide attacks the gelatin of

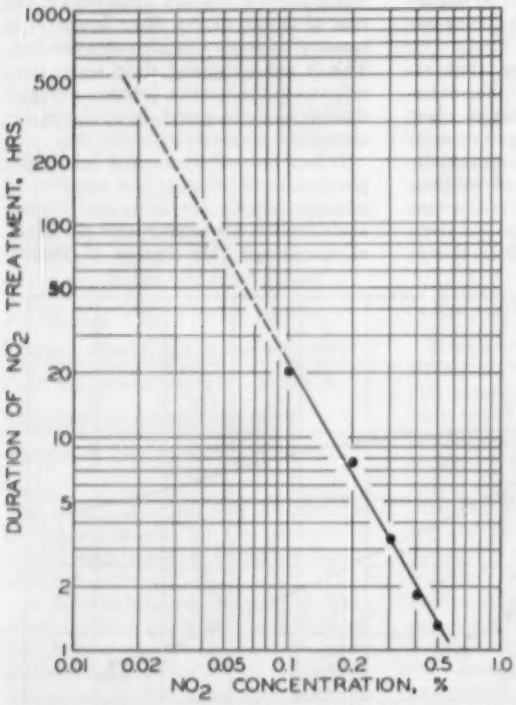


Fig. 6. Relation between nitrogen dioxide concentration and time of treatment required to produce a 0.20 decrease in film density at 50% R.H. at 75 F (interpolated from Fig. 4).

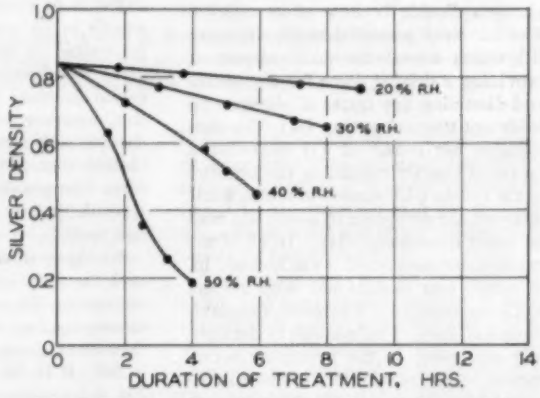


Fig. 7. Effect of the relative humidity of air containing 0.4% nitrogen dioxide at 75 F on the rate of density loss of processed Eastman Fine Grain Release Positive Film, Type 5302.

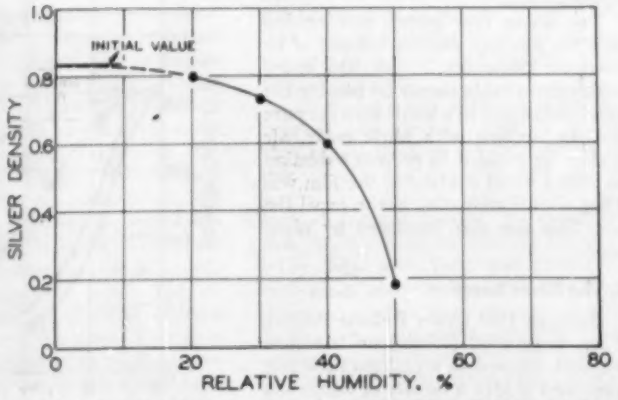


Fig. 8. Relation between the relative humidity of air containing 0.4% nitrogen dioxide and silver density for a treatment of 4 hr at 75 F (interpolated from Fig. 7).

the emulsion. Apparently the gelatin is attacked from the surface first as is the silver.

Degradation of gelatin is manifested by increased solubility in water resulting from cleavages in the molecule and a reduction in molecular weight. A test was made for initial decomposition of gelatin by marking with crayon upon the surface of the emulsion after treating it with nitrogen dioxide. The film was then placed in a beaker of water at 25 C. The beaker was immediately heated in such a way that the temperature was raised at a constant rate of approximately 3 C/min to boiling within 25 min of inserting the film. Elimination of the crayon mark was used as an indication of destruction of the surface of the emulsion. Except in the case of extremely severe nitrogen dioxide treatment, the surface of the gelatin was destroyed before the entire emulsion.

Figure 10 is a plot of time in the hot water test (time to destroy the emulsion surface) against duration of the nitrogen dioxide treatment for two concentrations of nitrogen dioxide at 50% R.H. The great endurance of the untreated gelatin is due to the hardness of the processed, Type 5302 emulsion. A comparison of Fig. 10 with Fig. 4 indicates that the silver image is largely destroyed before the gelatin exhibits degradation.

Damage to the gelatin as indicated in Fig. 10, however, does not necessarily indicate an unusable film. After 16 hr of treatment with 0.4% nitrogen dioxide, the gelatin will dissolve immediately in 25 C water as shown in Fig. 10. However, the condition of the gelatin would still not be critical enough at this point to prevent copying the film if the image were still intact. A silver image would be totally lost by this time, however, and is, in fact, the limiting component in the use of a black-and-white film attacked by nitrogen dioxide. After about two days of such treatment, however, the softness and tackiness of the gelatin becomes serious. It is this stickiness induced by nitrogen dioxide, and not brittleness, that is the limiting factor in the degradation of the gelatin under these conditions.

Treatment of the film with 100% nitrous oxide at 100% R.H. for over a week and treatment with 100% nitric oxide at 50% R.H. for 30 hrs at room temperature had no observable effect on the gelatin.

III. Cellulose Triacetate Safety Support

In determining the effect of nitrogen dioxide on triacetate safety support, the same processed Type 5302 film was used as in testing the silver image and the gelatin. In every case the film was treated with the emulsion still on it, as it would be in practice. The emulsion was removed before testing the support, however.

Since tests of the silver image and of the gelatin have the condition 0.4% nitrogen dioxide at 50% R.H. in common, this was chosen as the condition for treating the film for support tests. Four samples of the film were suspended in the reaction chamber while a steady flow of nitrogen dioxide diluted to 0.4% by air conditioned to 50% R.H. was passed over them. During the two days of each weekend the flow was discontinued, and the samples were left sealed in the static gas mixture. An untreated sample (A) was used as a control. The first treated sample (B) was removed from the reaction vessel after 32 hr of flow treatment. The second sample (C) was removed after an additional 64 hr of static treatment and 104 hr of flow treatment. The third sample (D) was removed after another 64 hr of static treatment and 104 hr of flow treatment. The last

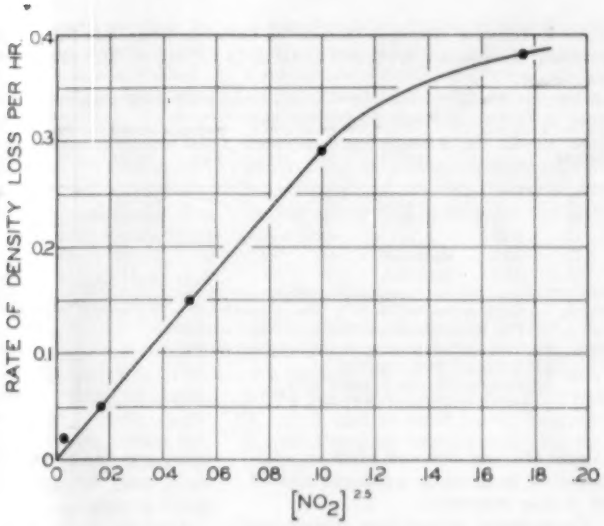


Fig. 9. Relation between a function of the nitrogen dioxide concentration and rate of density loss at 50% R.H. and 75 F (derived from Fig. 4). Equation of straight line is:

$$\frac{dD}{dt} = k\,[NO_2]^{2.5}$$

where D = silver density, t = time in hours, and k = a constant.

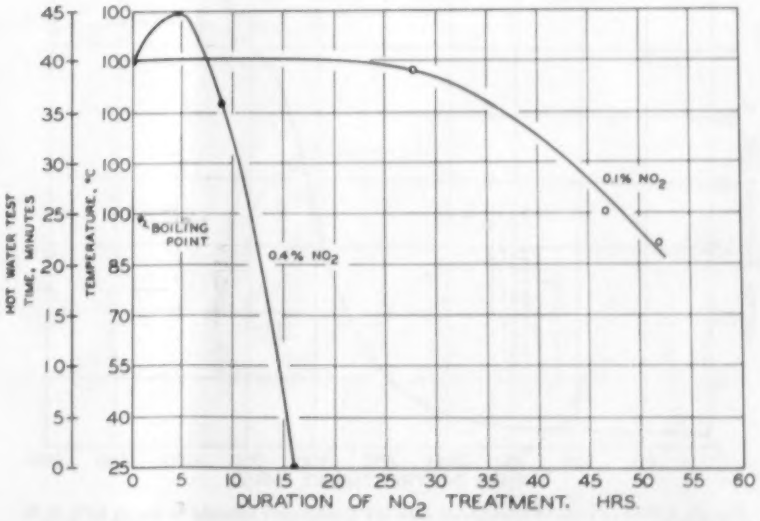


Fig. 10. Effect of time of treatment with nitrogen dioxide in air at 50% R.H. and 75 F on emulsion disintegration in water. Processed Eastman Fine Grain Release Positive Film, Type 5302. Film tested after treatment by immersion in water at 25 C, heating at rate of 3 C/min until boiling, then heating continued at 100 C.

Table I. Effect of Nitrogen Dioxide on Cellulose Triacetate Safety Support; First Experiment Treatment: 0.4% NO in Air at 75 F, 50% R. H. (Emulsion Removed After Treatment).

Sample	Time of treatment, hr	Intrinsic (a)	Solubility in solvents (b) Mixed solvent (c)	Acetone	Methyl Cellosolve	Acetyl content, % (d)	Water absorption, % (e)	Tensile strength, psi (f)	Elongation at break, %
A	0	2.12	+	–	–	42–44	2.0	14,600	27
B	32	2.26	+	+	–	40–42	2.4	14,400	25
C	200	2.37	+	+	+	30–40	4.8	15,200	30
D	368	insoluble	–	–	+	24–30	62	9,400	12
E	512	insoluble	–	–	–	< 24	62	11,000	13

Notes: (a) Support dissolved in 90% methylene chloride – 10% methyl alcohol.
(b) Plus sign indicates soluble; minus sign, insoluble.
(c) 90% methylene chloride – 10% methyl alcohol.
(d) Estimated from solubility.
(e) Immersed 30 min in water at 75 F.
(f) Instron machine at 75 F, 50% R.H., lengthwise direction.

sample (E) was removed after an additional 64 hr of static treatment and 80 hr of flow treatment.

Degradation of cellulose acetate by nitrogen dioxide might take the form of cleavage of the cellulose chains to give lower molecular weight units, or of splitting off acetyl groups from the molecule by acid hydrolysis. The first of these can be detected by a decrease in intrinsic viscosity, and the second by chemical tests for the acetyl group. Severe oxidation, as might occur with nitrogen dioxide, could produce a variety of decomposition products.

An attempt was made to determine the intrinsic viscosity of the triacetate support samples which had been treated with nitrogen dioxide. However, Table I shows that in this experiment, as the time of treatment increased, the samples became insoluble in the solvent mixture (90% methylene chloride – 10% methyl alcohol) before any loss in intrinsic viscosity was found. This change in solubility is easily accounted for by the loss of acetyl groups.

Analysis of the support for percent acetyl (by hydrolysis and acid determination) failed because of interference from acidic oxidation products of cellulose. Not enough material was treated to run specific chemical tests for acetyl. Therefore, it was necessary to estimate the acetyl level by an indirect method. It happens that several organic liquids are solvents for certain cellulose acetates but each liquid dissolves only acetates of a particular characteristic range of acetyl content as indicated below:

Solvent	*Cellulose Acetate Solubility Range in % Acetal*
90% methylene chloride – 10% methyl alcohol	30–44
Acetone	36–42
Methyl cellosolve	24–40

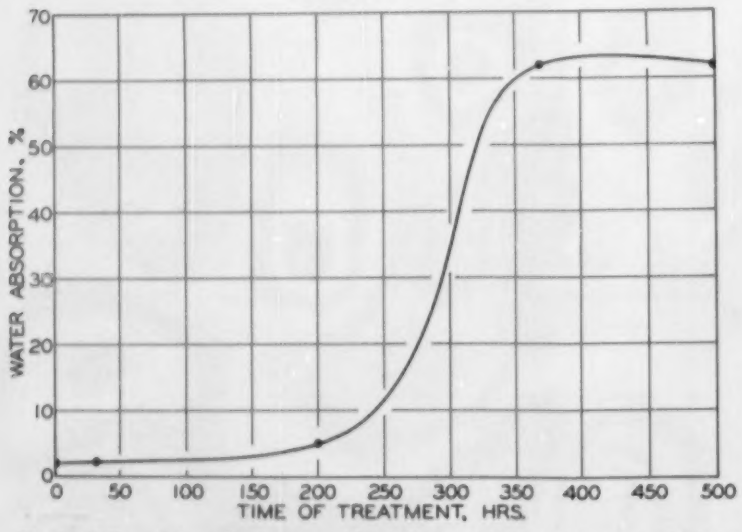


Fig. 11. Effect of time of treatment with 0.4% nitrogen dioxide in air at 50% R.H. at 75 F on the subsequent water susceptibility of the film support. Processed Eastman Fine Grain Release Positive Film, Type 5302, cellulose triacetate support. The film support was tested after treatment and removal of the emulsion by immersion in water for 30 min at 75 F and measuring the weight of water absorbed.

Therefore, by determining the solubility of the treated specimens in these solvents, an estimate of the acetyl content can be made, as indicated in Table I. This shows a continuous decrease in acetyl content as the time of treatment with nitrogen dioxide is increased. The loss of acetyl would probably be greater at the surface of the support than in the interior since cellulose acetate can be hydrolyzed uniformly only in solution.

Since the loss of acetyl groups results in increased water susceptibility, the four treated samples and untreated control were also tested for water absorption. The samples were placed in water for only 30 min because of the damaged appearance taken on by samples D and E when first wet. The results, shown graphically in Fig. 11 as percent water absorption, indicate a great change in the support after about 200 hr of nitrogen dioxide treatment. This coincides with a change in the physical appearance of the support. Tensile strength properties (Table I) also exhibit the greatest change after 200 hr of treatment.

In order to investigate further the question of cellulose chain rupture, another set of four samples of film was tested in which one sample was an untreated control with the emulsion removed. A second sample was dried by air passed through phosphorus pentoxide and was then treated with 100% nitrogen dioxide for 23 hr. A third sample was conditioned to 50% R.H. and then treated with 100% nitrogen dioxide. The last sample was conditioned to 50% R.H. and then treated with 100% nitrogen dioxide for 65 hr. After removal of the emulsion and the support plasticizer, intrinsic viscosities were run in 90% methylene chloride—10% methyl alcohol without any apparent interference due to loss of acetyl. A marked drop in intrinsic viscosity was found (Table II). Therefore, it seems that with a high concentration of nitrogen dioxide rupture of the cellulose chains predominates, whereas with a low concentration of nitrogen dioxide, in the presence of moisture, removal of the acetyl groups by hydrolysis is the preferred reaction.

Treatment of the film with 100% nitrous oxide at 100% R.H. for over a

Table II. Effect of Nitrogen Dioxide on Cellulose Triacetate Safety Support; Second Experiment Treatment 100% NO_2 at 75 F (Emulsion Removed After Treatment).

Sample	Film preconditioning	Time of treatment, hr	Intrinsic viscosity*
1		0	1.95
2	Dry air	23	1.98
3	Air at 50% R.H.	23	1.75
4	Air at 50% R.H.	65	1.05

* Support dissolved in 90% methylene chloride – 10% methyl alcohol.

week and treatment with 100% nitric oxide at 50% R.H. for 30 hr at room temperature had no observable effect on the triacetate base.

IV. Color Images

Five kinds of color film on acetate safety base were treated with nitrogen dioxide. These included dye-coupled images of negative, positive and reversal types, as well as imbibition color films. The films were treated for four hours at two nitrogen dioxide concentrations — 0.4% and 1.5% — in air at 50% R.H. All of the dye images were severely bleached and discolored by the nitrogen dioxide in proportion to the gas concentration.

Conclusions

Although silver, gelatin and cellulose acetate are all very stable materials, it should not be surprising that they are attacked by certain acids, oxidizing agents and other strong chemicals. Nitrogen dioxide, one of the three nitrogen oxides produced by the decomposition of nitrate film, is both acid forming and a strong oxidizing agent. It is extremely damaging to both silver and dye images, which are rapidly bleached and discolored, and to gelatin and cellulose acetate which are degraded and decomposed. Nitrogen dioxide attacks safety film in very low concentrations and its chemical activity increases with the equivalent relative humidity or moisture content of the film. (It is assumed that in the presence of moisture a portion of the nitrogen dioxide is first converted to nitric and nitrous acids.) Although the effect of temperature was not studied, the rate of these reactions is undoubtedly also increased by heat.

The other nitrogen oxides produced by decomposing nitrate film — nitrous oxide and nitric oxide — are apparently harmless to acetate film, although the latter is rapidly converted to nitrogen dioxide by air.

Both silver and dye images and the gelatin of the emulsion seem to be destroyed by nitrogen dioxide at the surface first, with the reaction of each gradually traveling deeper into the emulsion. The silver image is largely destroyed, however, before the gelatin gives much indication of any breakdown. When the silver is nearly all destroyed, evidence of gelatin breakdown appears at the gelatin surface and travels inward with duration of treatment with nitrogen dioxide. It is not until the silver image is totally destroyed that the condition of the gelatin becomes serious.

The triacetate safety support remains intact long after the emulsion has liquified completely. An estimate of the durations of treatment with 0.4% nitrogen dioxide at 50% R.H. that would so degrade each of the three film components to the extent that each could prevent copying the film is as follows: the silver image fades severely in about two hours, the gelatin becomes seriously sticky within about two days, and the triacetate safety support softens and loses its shape in about two weeks.

Although it is apparent from this work that certain storage conditions would minimize the deleterious effect of nitrate film decomposition products on safety film, by far the simplest and safest precaution is to separate all nitrate and safety films. In particular, these experiments emphasize the importance of not storing nitrate film in the same can with safety film.

Acknowledgments

The authors are indebted to Dr. C. R. Fordyce for guidance in carrying out this work, to Mr. E. E. Moyer, for supplying the film samples shown in Figures 1 and 2, and to those in the Eastman Kodak Company who assisted with the testing.

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Thomas Alva Edison's Early Motion-Picture Experiments

By HAROLD G. BOWEN

In the year 1887, Thomas Alva Edison conceived the idea of devising an instrument by means of which, used in combination with his phonograph, "all motion and sound would be recorded and reproduced simultaneously." Historical objects, documents, photographs and prints from early movies have recently been discovered in the archives of the Thomas Alva Edison Foundation and Museum in West Orange, N.J. This paper will reveal for the first time some aspects of the development of motion pictures from an idea in Edison's mind to his contributions to the technological and artistic aspects of the infant industry.

THERE is a familiar statement of Thomas Alva Edison's which was published in the *Century Magazine*, June 1894,[1] in which Edison said:

"In the year 1887, the idea occurred to me that it was possible to devise an instrument which would do for the eye what the phonograph does for the ear, and that by a combination of the two all motion and sound could be recorded and reproduced simultaneously. This idea, the germ of which came from the little toy called the Zoetrope, and the work of Muybridge, Marié and others has now been accomplished so that every change of facial expression can be recorded and reproduced life size. The Kinetoscope is only a small model illustrating the present stage of progress but with each succeeding month new possibilities are brought into view. I believe that in coming years, by my own work and that of Dickson, Muybridge, Marié and others who will doubtlessly enter the field, that grand opera can be given at the Metropolitan Opera House at New York without any material change from the original, and with artists and musicians long since dead."

In 1894, at the time Edison recorded these reflections, he had already accomplished a great deal. A practical strip film kinetograph and projector had been covered by patent applications. The 35mm film had been introduced which became the standard for the industry. The first motion-picture studio — the Black Maria (Fig. 1) — was built in West Orange, N.J. This kinetographic theater, which has been reconstructed (Fig. 2) as a part of the Thomas Alva Edison Foundation Museum in West Orange, N.J., revolved 360° on a pivot with its roof gaping at the elusive sun in order to floodlight the stage (Fig. 3) on which actors were performing kaleidoscopic glimpses of vaudeville acts.

During the middle and latter part of 1894, a great cast of performers were to troup across the boards of the Black Maria stage. A few of the films made in 1894 in the Black Maria might be of interest:

(1) First motion picture of a knockout in a prize fight — six rounds of a ten-round fight between Leonard and Cushing.

(2) First motion picture of a staged prize fight — six rounds of Corbett and Courtney — a kinetograph exclusive.

(3) Short subjects galore — cock fights, boxing cats, Sandow in feats of strength, dog tricks, acrobats, fencers, knife duels, Spanish, English, Japanese and French dancers, scientific pictures of insects taken through a microscope, "westerns" with Buffalo Bill Cody and Indians.

(4) Comedy and slapstick described as a barber shop skit, a burlesque boxing bout with two comedians named Long and Short and a tramp clown.

(5) Twenty-four actors gave us the first stage show motion-picture spectacle.

(6) Trick photography had not been overlooked as W. K. L. Dickson appeared in company with himself in a film as a ghostly conscience in one sequence; and, beheaded, carried his head on a platter in another.

(7) Sound pictures had been successful since Dickson played a violin as two men danced. This film incidentally has been preserved and is available for viewing. An organ grinder had been recorded for eye and ear and a still photograph in the archives of the Edison Foundation shows an audience of one seeing and listening to a peep-hole kinetoscope equipped with ear tubes.

As techniques were sharpened, Edison made so bold as to twist the tail of the unknown by pointing the camera out of the window of the Black Maria for outdoor scenes of Professor Batty's Trained Bears, a picnic alongside the Black Maria fence, an acrobat doing somersaults on the greensward and an outdoor picture of charging horsemen.

Where would this lead? Even a motion picture of Thomas Alva Edison at work in his chemical laboratory on June 5, 1897, would be filed for posterity. Shortly, commercial movies, newsreels and shorts were to be made by the hundred and screened by Edison in the library of what is now the Edison Museum in West Orange, N.J. All sorts of subjects were to be filed in the film library "without any material change from the original and with artists and musicians long since dead." In the late 1890's and early 1900's, motion-picture films were to be taken by Edison with thousands and millions of frames showing matters of interest such as world's fairs and other expositions, disasters, Presidents, wars, travel and science, documentaries, advertising, education, human interest, sports, fantasy, comedy, glamour, and finally, in 1903, the first stories: *The Life of An American Fireman* in January 1903, and *The Great Train Robbery* in December 1903.

Films with a plot had arrived, and instead of a series of unrelated travelogues, newsreels and gimmicks, aimed at catching the curious public's attention as they marvelled at Thomas Alva Edison's latest technological wonder, films now had a beginning and an end heralding the advent of the motion-picture industry as entertainment.

But let us go back to the beginning. How did Edison bring to fruition in a practical way what the human race had been trying since the time the first cave man scratched on a cave wall—to permanently record motion?

In searching through the files of the Thomas Alva Edison archives, a person must be careful not to get bogged down in the wealth of material pertaining to the varied interests of Edison. The temptation to follow interesting trails that open up to an author must be sternly resisted. We have therefore endeavored to skim the cream off the top of the dish which contains successful experimentation on the motion-picture camera and report documentary material which sheds new light on Edison's pioneering accomplishments. Much work still must be done in the archives before the full story can be told. We have learned many new interesting things in the last year and we have made many exciting discoveries of Edisonia—the most important of which were first exhibited at the Library of Congress, Washington, D.C., and are now to be seen at the Edison Museum. We expect there will be more.

We might logically raise the question of what prompted Edison to send W. K. L. Dickson, a "young laboratory assistant keen on photography" to New York

Presented on May 3, 1954, at the Society's Convention at Washington, D.C., by Paul Busse for the author, Vice-Admiral Harold G. Bowen, USN (Ret.), then Executive Director, Thomas Alva Edison Foundation, West Orange, N.J.
(This paper was received on March 21, 1955.)

Fig. 1. The "Black Maria," the first motion-picture studio in the world, erected on the grounds of Edison's West Orange Laboratory. It was completed on February 1, 1893. This was three and one-half years after his invention of the first practical and commercially successful strip-film motion-picture camera.

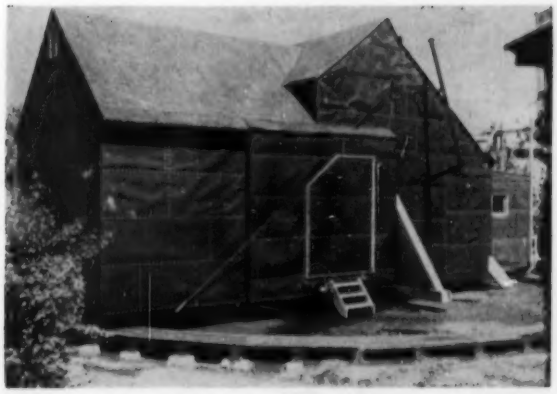


Fig. 2. This replica of the first motion-picture studio in the world, which was nicknamed the "Black Maria," has been built on the grounds of the Thomas Alva Edison Foundation Museum, West Orange, N.J., a short distance from the site of the original. The structure moves around on a pivot and the roof can be raised in order to use the sun's rays as for early movie making. Films are shown in the "Black Maria" daily, except Mondays and Tuesdays, at 11:30 A.M. and 4:00 P.M.

City during early December of 1887 to purchase photographic material from the Scovill Manufacturing Company. Aside from Dickson's own account[2] of preliminary project planning by Edison while at his Newark Laboratory, a letter from Scovill to Edison dated December 17, 1887, is the first direct evidence that systematic experiments were to be started in Room No. 5 of the new West Orange Laboratory "to do for the eye what the phonograph had done for the ear." The new Laboratory was opened in late November 1887, and there were big plans for the new project.

Dickson himself had said that one large room in the Laboratory was to be set aside for kinetographic experiments. In making a cursory examination of the extensive documentation in the archives, we are able to conclude that through Edison's avid reading of the *Scientific American* and other scientific and technical publications, he was undoubtedly aware of articles being published as early as October 19, 1878, on the advances being made throughout the world in the techniques of photography and particularly experiments by Muybridge on animal locomotion. Edison himself stated that the biggest spur to his interest in living photography came from his work in the development of one of history's most classical inventions, the recording and reproducing of sound by his device to be popularized as the phonograph.

After the successful invention of a commercially practical incandescent lamp and a system for the generation and distribution of electrical energy, commemorated in 1954 as Light's Diamond Jubilee, Edison turned, in 1887, to the further development of the phonograph which he had set aside in 1878. He also was free to begin his experiments on the problem of accelerated photography as well as the development of a mechanism for both taking and viewing pictures in rapid succession.

Characteristically, Edison approached his photographic problem in a most practical manner. Unlike previous investigators, Edison realized that he needed to devise a mechanism that would start and stop many times per second with little or no inertia as it recorded tiny pictures. In his earliest experiments, microscopic photographs were made on the surface of a revolving cylinder similar to that of Edison's wax cylinder phonograph; and, in fact, using an adaptation of his phonograph mechanism. The pictures were "photographed in a continuous spiral line on a cylinder or plate in the same way that sound is recorded on the phonograph."

But perhaps Edison's own accomplishments and thoughts written in his own hand on October 8, 1888, and filed as caveat No. 110 on October 17, 1888,[3] will provide the best summary of his cylinder experiments.

This caveat, the handwritten draft

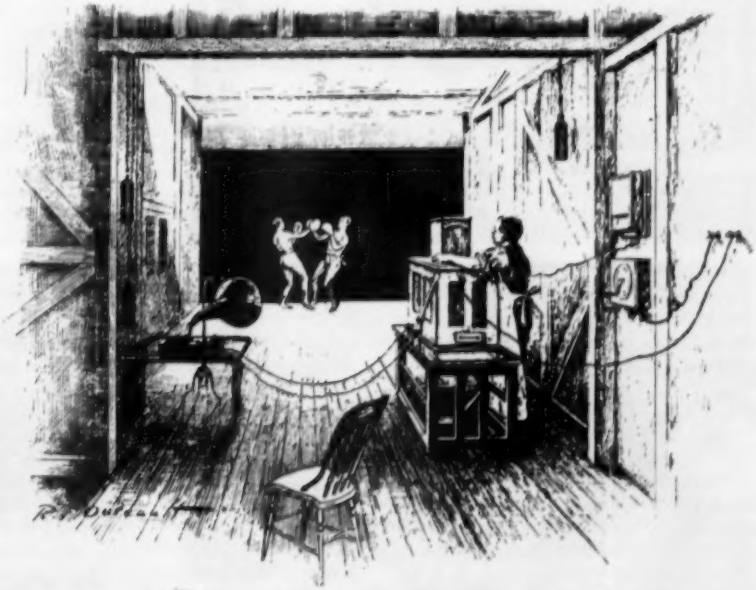


Fig. 3. This drawing of the inside of the "Black Maria," the world's first motion-picture studio, first appeared in the "Electrical World," June 16, 1894. The camera is seen at the right while the phonograph apparatus indicates that the picture being filmed was an early "talkie."

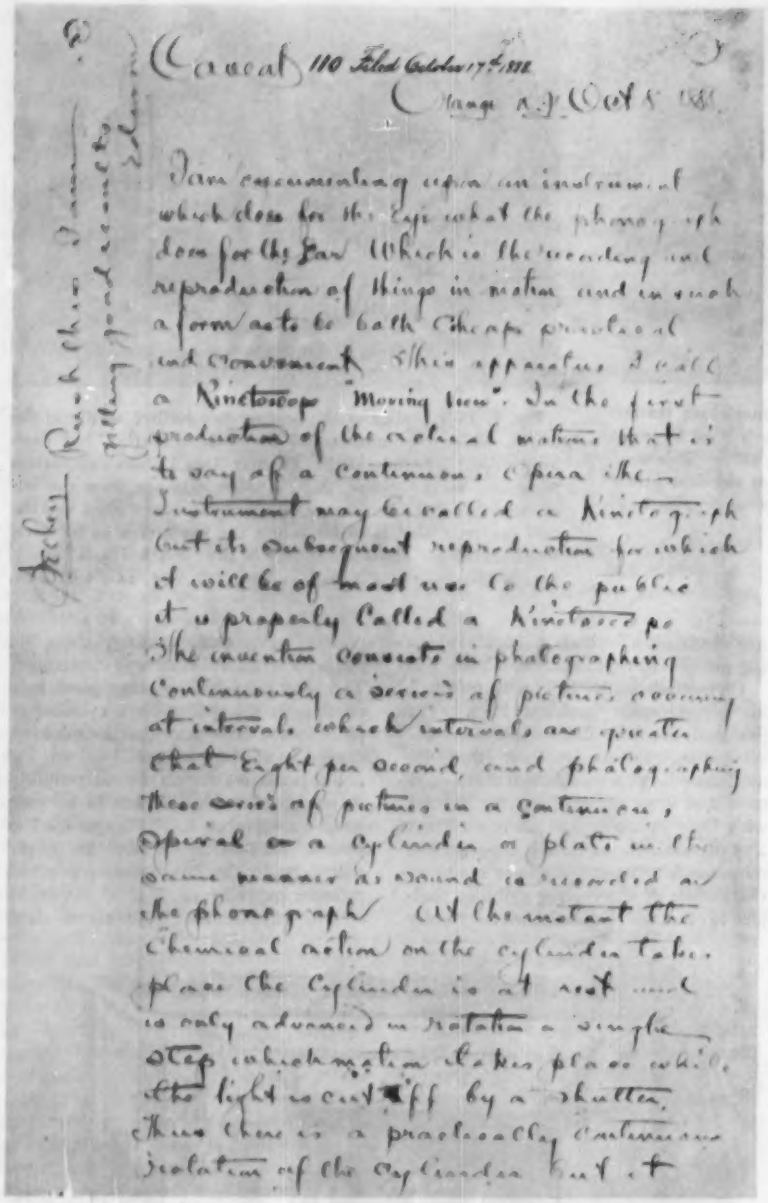


Fig. 4. First page of Edison's handwritten caveat of October 8, 1888, announcing preliminary experiments on motion-picture apparatus.

never before published, shows Edison's personal annotation to his lawyer: "Seeley, rush this I am getting good results;" signed/Edison.

The text is as follows (Fig. 4):

"I am experimenting upon an instrument which does for the eye what the phonograph does for the ear, which is the recording and reproduction of things in motion, and in such a form as to be both cheap, practical and convenient. This apparatus I call a Kinetoscope 'moving view.' In the first production of the actual motions that is to say of a continuous opera the instrument may be called a Kinetograph but its subsequent reproduction for which it will be of most use to the public it is properly called a Kinetoscope. The invention consists in photographing continuously a series of pictures occurring at intervals which intervals are greater than eight per second, and photographing these series of pictures in a continuous spiral on a cylinder or plate in the same manner as sound is recorded on the phonograph. At the instant the chemical action on the cylinder takes place the cylinder is at rest and is only advanced in rotation a single step which motion takes place while the light is cut off by a shutter. Thus there is a practically continuous rotation of the cylinder but it takes place step by step and at such times as no photographic effect takes place. For illustration say the cylinders may be about the same size as the phonograph, the number of threads to the inch on the feed screw is about 32. This will give a photograph image about $\frac{1}{32}$ of an inch wide, giving about 180 photographs per revolution or 42000 for the whole cylinder. It is probable that 25 per second will be sufficient to give the illusion as if looking at the actual scene with all its life and motion this will therefore record and reproduce all the motions or scenes occurring during a period of 28 minutes.

"By gearing or connecting the Kinetograph by a positive mechanical movement, a continuous record of all motion is taken down on the Kinetograph and a continuous record of all sounds are taken down by the phonograph and by substituting the photograph recording devices on the Kinetograph for a microscope stand and objective it becomes a Kinetoscope and by insertion of the listening tubes of the phonograph into the ear the illusion is complete and we may see and hear a whole opera as perfectly as if actually present although the actual performance may have taken place years before.

"I prefer to use the cylinder form instead of a plate with volute spiral. A continuous strip could be used but there are many mechanical difficulties in the way while the cylinder with the microphotographs taken on its surface in continuous spiral permits of the use of very simple mechanism. The cylinders which are hollow shells slip onto a taper cylinder permanently connected to the instrument just as in the phonograph. The shells may be of any substance which will preserve its shape such as plaster paris and other mouldable bodies. The collodion or other photographic film may be flowed over it just as if it was an ordinary flat photo plate, a positive being taken; but if it is desired to produce a negative series of photographs a glass cylinder is used—surface of the cylinder or shell is flowed and the records taken. The cylinder or shell being exceedingly thin say of mica is slipped over the regular cylinder to be used in practice whose surface is sensitized and printed from the negative by light in straight lines without reflection from side surfaces. A positive may be taken and with proper lenses reproduced on another cylinder just as one photograph may be taken from another.

"The permanent cylinder may even be covered with a shell and a thin flat film or transparent tissue sensitized be wrapped around it which after being filled with images may be detached from the shell and used as a negative to print many positives on sheets which are permanently pasted on shells for actual use, perfect alignment and no eccentricity of

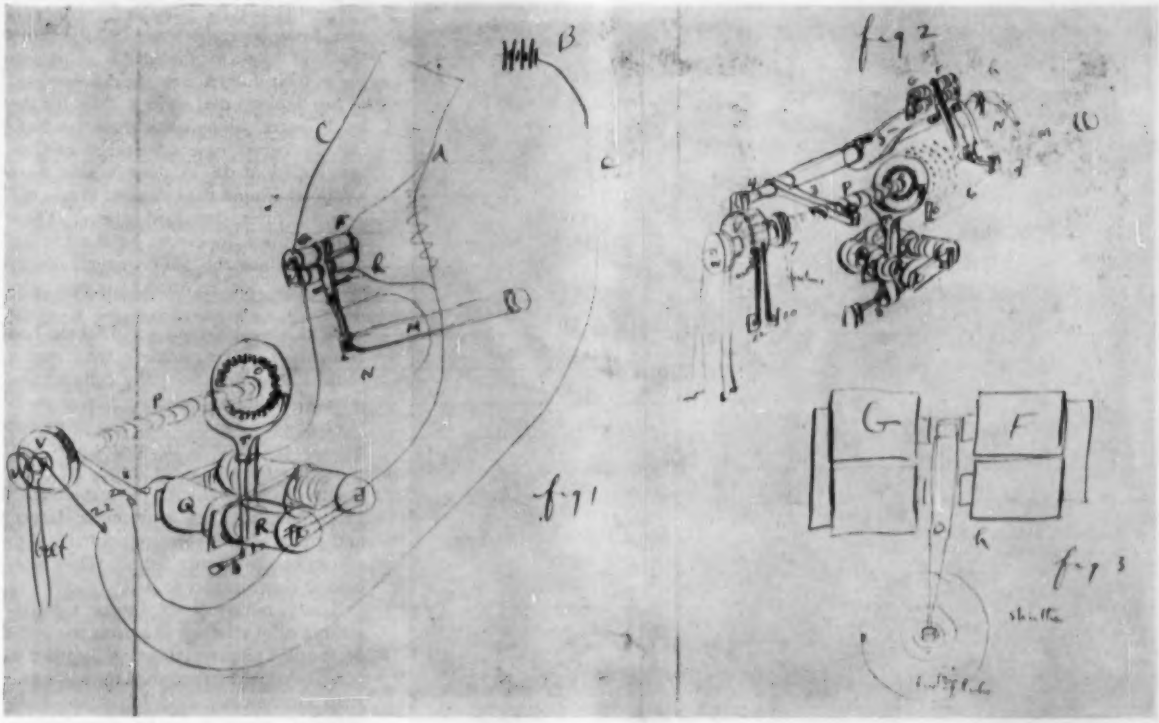


Fig. 5. Figure 1, Edison's first motion-picture caveat — cylinder Kinetograph with electromagnet intermittent motion control.

Fig. 6. Figures 2 and 3, Edison's first caveat on cylinder Kinetograph.

the surface must be had as the focus of the observing objective will be changed, although a presser foot might move the objective and thus keep it in focus even if the surface of the cylinder did not run true.

"In figures 1 [Fig. 5], 2 [Fig. 6], 3 [Fig. 6], I illustrate diagrammatically the principal feature of the apparatus. W, figure 2, is the drive pulley preferably run by a belt from an electromotor. V, the breakwheel. P is the feed screw as in the phonograph. 7 a friction connecting the drive pulley and break wheel with the screw P and attached apparatus 3 the traveller arm for carrying the microphotographic apparatus while recording and the observing microscope when reproducing. 5 is the arm carrying the above. A shutter with two openings see figure 3 is vibrated by double magnets G and F between the surface of the cylinder and the recording or reproducing apparatus M. The lever of the vibrator is pivoted at h. When the lever is to the right or to the left the aperture is opposite the objective but when in the act of moving the line of vision between the cylinder and objective is cut off by the space between the two holes in the shutter. When the shutter is at either the left or right limit and still the cylinder is also in a state of rest and no movement of the cylinder takes place while an aperture is opposite the objective, hence in recording and reproducing the photographic surfaces are in a state of rest, the intermittent rotation of the cylinder takes place by means of an escapement O and fork T reciprocated by the double magnets Q and R. The reciprocation of the shutter as well as the escapement being controlled by magnets and the break wheel V and springs 20 and 22, one spring being in contact with the metallic part of the wheel (see figure 1) while the other is on the space between. On a further rotation of the break wheel the opposite effect occurs and the spring which was previously on insulation now comes in electrical contact with the wheel and the other set of magnets are energized thus advancing the cylinder $\frac{1}{3}\frac{1}{2}$ of inch only at the time the shutter has closed the vision between objective and cylinder. As the speed of W should be much greater than P, the break wheel V need have but few breaks. This insures greater rapidity of advancement of the cylinder during the interval when the shutter closes the light beam off.

"The motor should be governed so as to produce even results. Of course in practice the mechanism will be considerably changed from that shown as the figures are merely diagrammatical so as to simplify the explanation of the invention.

"A tuning fork with break might control the magnets, the fork being kept in continuous vibration by a magnet and

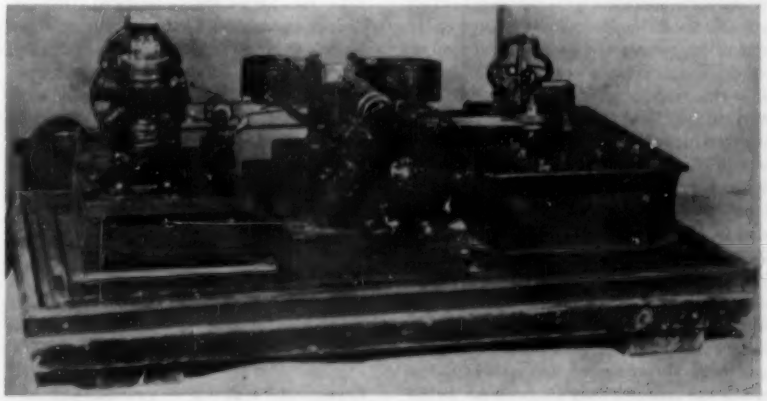


Fig. 7. Motion-picture camera, or strip Kinetograph, made and used by Thomas A. Edison at his West Orange Laboratory in 1889.

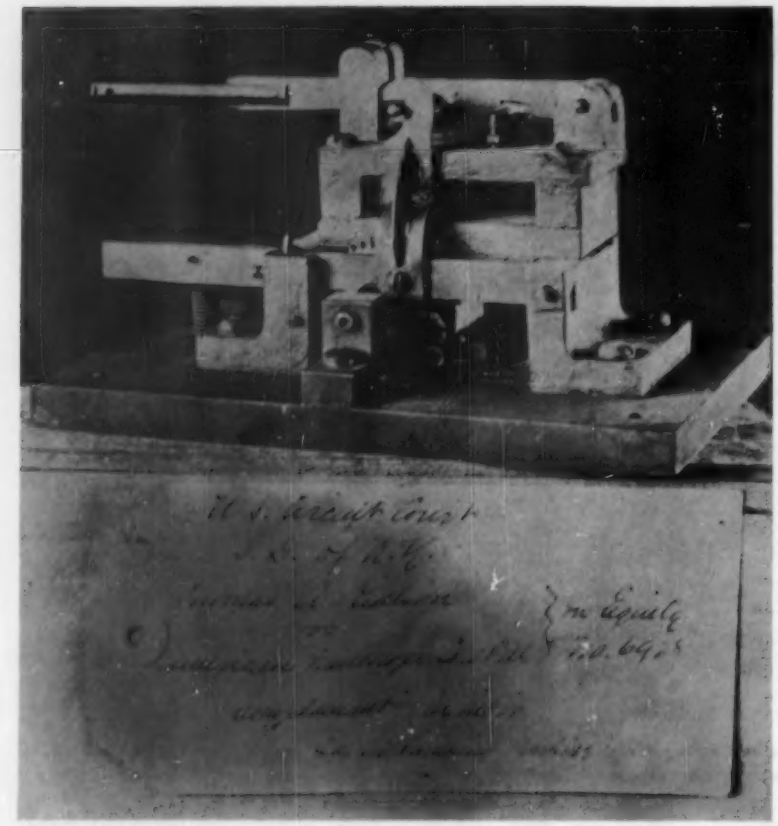


Fig. 8. Hand perforator used for punching film strips for Edison's 1889 strip Kinetograph.

automatic make-and-break contact. The levers T and the shutter lever may be reeds or tuning forks themselves, their magnets being in one circuit and controlled by a master fork or reed electrically operated or by a self make-and-break attached to one of them. The break wheel V might be run by a governed motor or mechanism independent of the motor driving the main devices. The levers T and shutter may be operated mechanically by means of an undulating surfaced rotating wheel which reciprocates a lever which not only serves to release the escapement O but works the shutter, a strip parallel to the cylinder and between the objective and surface of cylinder may be reciprocated up and down two continuous apertures are in the strip. The whole of the shutter is then detached from the travelling arm rendering the images free from blurring due to any movement or vibration of the arm. A plate machine in the feeding mechanism, say a volute spiral or worm, or multiplying gearing may be used and flat records taken instead of using cylinders but I do not think this form is so practical. By using very large transparent shells the pictures may be even projected on the screen as in microphotographic projection or enlargement, the cylinder being revolved and the source of light inside of the cylinder, negative records being only recorded." s/Thos. A. Edison

A few parts of this early cylinder apparatus have survived thanks to their having been used as exhibits in patent litigation. One piece is a slotted cylinder of phonograph size, another is a larger cylinder still showing patches of photographic emulsion on its surface, a third is a large cylinder with one edge studded with pins for making electrical contacts. These pins are $\frac{1}{4}$ in. apart, and may have served as circuit-closers for illuminating, by electric spark, the $\frac{1}{4}$-in. pictures. This cylinder, which was on exhibit with the others at the Library of Congress in 1954, is slotted and would hold a sensitized sheet 3 in. wide by 14 in. long, on which about 700 $\frac{1}{4}$-in. pictures could be taken in a spiral line. Prints of portions of three different sheets of these $\frac{1}{4}$-in. pictures have survived the ravages of time. They show Fred Ott, one of Edison's workmen, wrapped in a white sheet tied in the middle, waving his arms and "making a monkey of himself."

These and similar pictures were being made, on steadily improved cylinder mechanisms, up to the early part of 1889, as disclosed in two more recently discovered Edison caveats dated February 2 and May 20 respectively. Mechanisms that had "done for the ear" were persisting in their influence on the development of mechanisms that were to "do for the eye." Better photographic materials facilitated progress, especially sheets of Carbutt celluloid 18 in. long which were wrapped around the cylinders to take the $\frac{1}{4}$-in. pictures described above. These $\frac{1}{4}$-in. pictures appear to be the last attempts to use the phonograph-cylinder conception for recording motion pictures.

By this time Edison and Dickson had recognized that to achieve their goal a radical departure from the cylinder approach would be necessary. New apparatus had been constructed and tried out for taking pictures in a straight line, using narrow strips cut from the 18-in. sheets of celluloid. As the experiments progressed, pictures were made larger, and strips of film were cemented end to end to obtain greater length. They were getting closer to success.

Before referring to Edison's handwritten original draft of his fourth caveat on motion pictures, dated November 2, 1889, in which he described the successful strip kinetograph, one important technological event must be described in which George Eastman plays the leading role. In the biography of George Eastman by Carl W. Ackerman,[4] there are quoted two letters which document the Edison-Eastman connection:

"Opening the mail at the office one morning Eastman found the following inquiry from Edison:

Orange, N.J., May 30, 1889

The Eastman Dry Plate Co.,
Rochester, New York

Gentlemen:

Please quote us discount upon your Kodak camera, your list price, $25.00. Also discount upon reloading camera, list price $10.00.

Yours truly,
EDISON PHONOGRAPH WORKS,
T.A.E.

On September 2, Eastman received another letter from the Edison Laboratories:

Dear Sirs:

Enclosed please find sum of $2.50 P.O.O. due you for one roll Kodak film for which please accept thanks — I shall try same today and report — it looks splendid — I never succeeded in getting this substance in such straight and long pieces —

Sincerely yours,
W. K. L. Dickson

Can you coat me some rolls of your highest sensitometer — please answer."

Dickson's own account of Eastman's film and its application was described in the December 1933 issue of this *Journal*[5] from which I quote:

". . . it was rumored that the Eastman Company was experimenting on a new

product for their cameras, and that it would be shown at the New York Camera Club by Mr. George Eastman's representative. At the end of the meeting, which I attended, I approached the demonstrator, explained what we wanted and asked for the 2 by 4 inch sample to show to Mr. Edison. The representative quickly grasped the situation and its great possibilities, and invited me to come out to Rochester to see Mr. Eastman, which I did the next day. I knew then that we should reach our goal if the Eastman Company could supply this new product in good lengths. When I showed Mr. Edison my new find his smile was seraphic; 'Good,' he said, 'we can now do the trick — just work like hell . . .'

"A few weeks elapsed before I saw Mr. Eastman again and explained our difficulties, which were remedied principally by reducing the coarseness of the silver bromide. This change proved most satisfactory. When perforating the film, however, the sprocket wheel often broke through and tore the film. I had to ask Mr. Eastman whether he could make his base tougher and less brittle, which he did.

"Meanwhile we had to use this rapid negative for our positive prints; and although they lacked pluckiness, we partly overcame it by using potassium bromide in our developing bath to reduce its sensitiveness. This caused me to apply again to Mr. Eastman for a less sensitive product or emulsion similar to that used in lantern slide work which we ultimately received.

"We were, however, much troubled with 'frilling,' and often a gelatinous mass of pictures was left at the bottom of our developing or fixing troughs, while the base remained on the drum, a situation which we found very trying and necessitated further conferences on this matter. Mr. Eastman, however, managed to overcome this difficulty in part.

"About this time we received six rolls of improved negative film 50 feet long, and later some slow positive film. All these samples and experiments were made exclusively for us by Mr. Eastman, who took an ever-increasing interest in what we were doing."

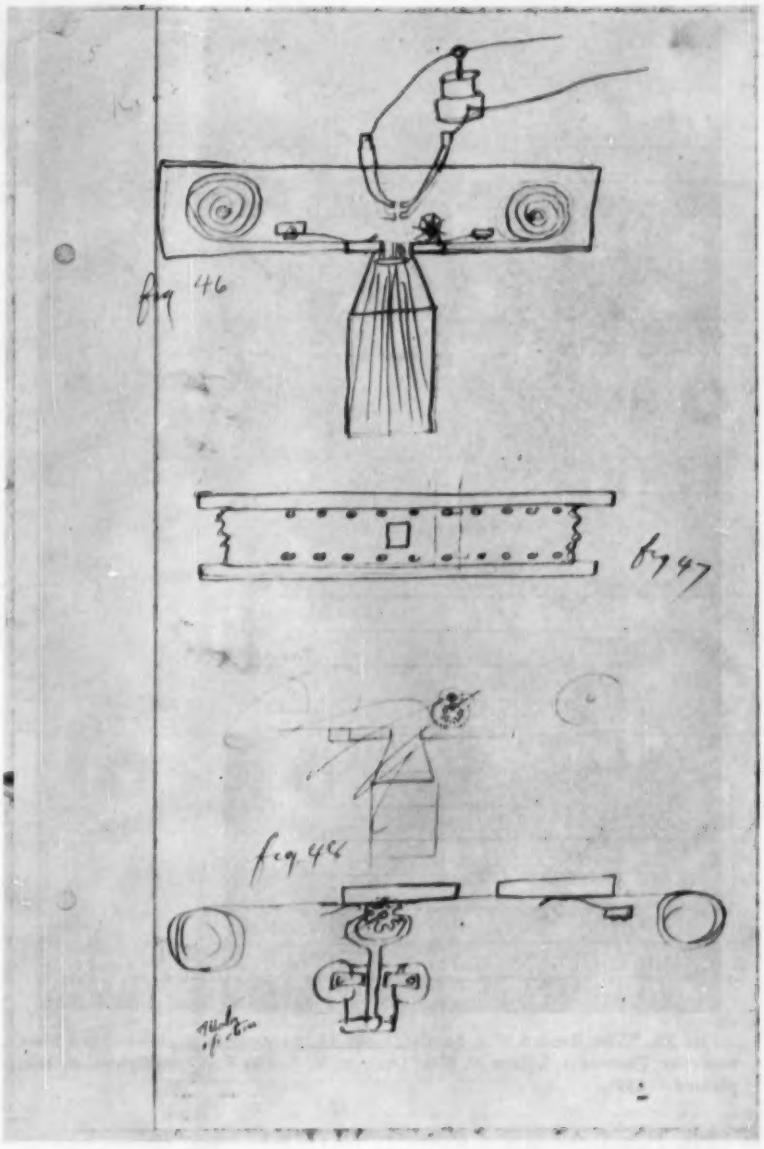


Fig. 9. Sketches from Edison's motion-picture caveat, November 2, 1889, showing the double perforated film — the prototype of modern standard film.

With this valuable contribution of George Eastman, the continuous strip film Kinetograph was now practical. The 1889 strip Kinetograph took pictures $\frac{1}{3}$ in. in diameter on a strip of film $\frac{3}{4}$ in. wide which ran horizontally through the camera. Along its lower edge the strip had perforations which fitted the teeth of a sprocket wheel; and the sprocket, by means of a Geneva movement or the equivalent, moved the film intermittently, one step for each exposure, past a revolving shutter. Like the earlier cylinder apparatus, this machine was also used for viewing the pictures. By changing to a smaller sprocket wheel to allow for shrinkage of the film when developed, the finished picture could be run through the camera, where it could be viewed directly, or, with a change of lens and addition of a light source, the picture could be projected on a screen. This camera (Fig. 7) has survived, almost complete, as a legal exhibit labelled "Edison's 1889 Strip Kinetograph." It was on display at the Library of Congress and is now on permanent exhibit in the Edison Museum, West Orange, N.J. With it is a little hand-operated device for punching the holes along one edge of the $\frac{3}{4}$-in. strips (Fig. 8).

The Edison 1889 Strip Kinetograph embodied the solution of the basic problems of the motion-picture art, both for making the pictures and for exhibiting them. The Strip Kinetograph (1889) is the first practical and commercially successful motion-picture machine to use a continuous film strip. On August 24, 1891, a patent was applied for and issued on August 31, 1897, as No. 589,168. This machine made practical the strip-film motion-picture camera. All later cameras and projectors, including Edison's own, are merely refinements of this primitive apparatus — the prototype for all.

Having solved the basic problems, Edison proceeded to build a better and larger camera. The pictures were eventually enlarged to 1 in. × $\frac{3}{4}$ in. The film strip, now available on special order from Eastman in 50-ft lengths, was used

Fig. 10. "The Record of a Sneeze," one of the earliest motion-picture films made by Thomas A. Edison at West Orange, N. J. The first copyrighted motion picture — 1894.

in 1⅜ in. (35mm) width, and perforations were made along both edges — four to a frame. This film size is still standard. Cameras incorporating these improvements took motion pictures circa 1890 to 1894, including the early Black Maria films. One of these cameras, perhaps the first one, is now on display in the Henry Ford Museum in Dearborn, Mich.

Thus, by the close of 1889, Edison had solved the major problems in doing for the eye what the phonograph had done for the ear and a crude kinetographic camera as described in his handwritten caveat No. 4 dated November 2, 1889,[3] had been constructed and tested:

"Figure 46 [Fig. 9] is a kinetoscope. The sensitive film is in the form of a long band passing from one reel to another in front of a square slit as in Figure 47 [Fig. 9]; on each side of the band are rows of holes exactly opposite each other and into which double toothed wheels pass on (as) in the wheatstone automatic telegraph instrument. This ensures a positive motion of the band. The film being transparent, the Leyden jar spark illuminates back and by means of a lens the image is projected on a screen. Instead of the Leyden spark a continuous light with revolving shutter may be used. The operation of photographing is as follows — in front of the apparatus where the film is exposed the microphotographic apparatus is placed. A motor, preferably an electric motor, drives a shaft at great velocity; on this shaft is a sleeve carrying double toothed wheels engaging in the holes of the band of photo film. The connection between this sleeve and shaft is a friction one; on the sleeve is a release escapement with fork connected to the tongue of a polarized relay. This polarized relay is reciprocated by means of a break wheel alternating currents through it or by an alternating small dynamo. The time is so arranged with these currents that the band is advanced one step for a photograph 10 times in one second, the escapement working of course 10 times in a second, but of this $\frac{1}{10}$ of a second, $\frac{9}{10}$ths of the $\frac{1}{10}$ the band is still, with (while) $\frac{1}{10}$ of the $\frac{1}{10}$ of a second the band *is* moving. In other words: if there were but one photograph to be taken in ten seconds the band would be shifted in one second and stand still nine seconds, and this proportion holds good up to any number of photographs per second until the mechanism fails to act, by thus causing the band to be in a state of rest $\frac{9}{10}$ of the time, yet taking 10 photographic images per second, most perfect results are obtained and the great necessity of a shutter is modified. The break wheel which controls the polarized relay may be connected to the screw shaft of the phonograph, hence there will be a positive connection and all the movements of a person photographed will be exactly coincident with any sounds made by him.

"Figure 48 [Fig. 9] gives rough idea of positive feed mechanism; of course this principle can be applied to cylinder covered with the photo material as well as in bands. When a Leyden spark is used the break wheel is arranged that it takes place while band is in state of rest, or if shutter used reciprocating or revolving it is to be released by the same devices that release and move the band and the shutter so devised that light only passes to the image while projecting it on the screen when in a state of rest."

Edison's goal of 1887 described in the 1894 issue of *Century Magazine* quoted in the opening paragraph of this paper, had at last been attained.

The idea had been reduced to practice. A patent application had been filed. An instrument had been devised that could do for the eye what the phonograph had done for the ear. The very change of facial expression could be recorded on standardized 35mm film and reproduced life size without any material change from the original with artists long since dead — and copyrighted too! (Fig. 10).

References

1. A. and W. K. L. Dickson, "Edison's invention of the Kineto-Phonograph," *Century Magazine, 48:* 206–214, June 1894.
2. W. K. L. Dickson, "A brief history of the Kinetograph, the Kinetoscope and the Kineto-Phonograph," *Jour. SMPE, 21:* 435–455, Dec. 1933.
3. Edison Caveat No. 110, Handwritten Draft in Archives of Thomas Alva Edison Foundation, West Orange, N.J.
4. Carl W. Ackerman, *George Eastman*, Houghton Mifflin Co., Boston and New York, 1930.
5. Edison Caveat No. 117, Handwritten Draft in Archives of Thomas Alva Edison Foundation, West Orange, N.J.

motion-picture standards

Revision of American Standard—PH-22.35, 16-Tooth 35mm Motion-Picture Projector Sprockets

A proposed revision of American Standard Z22.35-1947 is published on this page for a three-month period of trial and criticism. All comments should be sent to Henry Kogel, SMPTE Staff Engineer, prior to December 15, 1955. If no adverse comments are received, this proposal will then be submitted to ASA Sectional Committee PH22 for further processing as an American Standard.

The 1947 standard was first reviewed by the Film Projection Practice Committee in 1952 in accord with ASA rules requiring review of all American Standards every five years. This review indicated the existence of a wide divergence in commercial practice in regard to dimension B, the base diameter of the sprocket. Surveys were conducted as to the magnitude of this divergence and several efforts were made to reach agreement on one or another specific value for this dimension. When it became apparent that agreement could not be reached, it was decided to process this standard without specifying this value. Instead, it was agreed to indicate the range of this dimension in commercial practice as well as the factors affecting the choice of an optimum value.

While this is the basic change, two additional modifications have been made to further improve the standard: 1) A paragraph has been added which limits the scope of the standard to sprockets employed in the picture projection mechanism prior to the advent of CinemaScope; 2) The various types of sprockets are defined with respect to their function.

This draft has been approved by the Film Projection Practice and Standards Committees.—H.K.

Two American Standards—PH22.15, .16—1955

Published on the following page are two American Standards approved by the American Standards Association on July 8, 1955: PH22.15-1955, 16mm Film Perforated One Edge, Usage in Camera (Revision of Z22.15-1946); PH22.16-1955, 16mm Film Perforated One Edge, Usage in Projector (Revision of Z22.16-1947).

These standards were published for trial and comment in the September 1954 Journal. The sole change since then has been an editorial modification in the diagrams to make them consistent with developing international standards.—H.K.

Proposed American Standard

16-Tooth 35mm Motion Picture Projector Sprockets

(Second Draft)

PH22.35

Rev. Z22.35-1947

1. Scope

1.1 This standard is applicable to sprockets used in conjunction with 35mm motion picture film perforated in accordance with either American Standard PH22.1-1953, Dimensions for 35mm Motion Picture Film, Alternate Standards for Either Positive or Negative Raw Stock or PH22.36-1954, Dimensions for 35mm Motion-Picture Positive Raw Stock.

1.2 This standard is limited to sprockets employed in the picture projection mechanism.

2. Definitions

2.1 Feed Sprocket—A sprocket which pulls the film against tension. Originally applied to the upper sprocket in the projector.

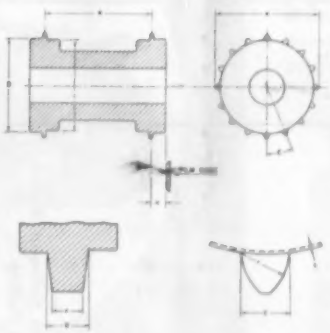
2.2 Hold-Back Sprocket—A sprocket which holds back the film against tension. Originally applied to the lower sprocket in the film take-up section of the projector. In many present day projectors the sprocket occupying this lower position no longer has the hold-back function and is, instead, an idler sprocket.

2.3 Idler Sprocket—A sprocket which neither pulls nor holds back film against tension. Normally used to maintain a film loop.

2.4 Intermittent Sprocket—A feed sprocket employed to advance the film one frame at a time before the picture aperture at the designated frame rate.

3. Dimensions

3.1 The sprocket dimensions shall be as given in the diagram and table provided:



	Feed Sprocket		Intermittent Sprocket		Hold-Back Sprocket	
	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters
A	1.897 ± 0.001	27.86 ± 0.03	1.897 ± 0.001	27.86 ± 0.03	1.897 ± 0.001	27.86 ± 0.03
B	0.655 +0.000 −0.002	16.64 +0.00 −0.05	0.655 +0.000 −0.002	16.64 +0.00 −0.05	0.655 +0.000 −0.002	16.64 +0.00 −0.05
C	0.055 +0.000 −0.002	1.40 +0.00 −0.05	0.055 +0.000 −0.002	1.40 +0.00 −0.05	0.055 +0.000 −0.002	1.40 +0.00 −0.05
D	0.055 +0.000 −0.002	1.40 +0.00 −0.05	0.055 +0.000 −0.002	1.40 +0.00 −0.05	0.055 +0.000 −0.002	1.40 +0.00 −0.05
S	33 Degrees 20 Min ± 1 5 Min		33 Degrees 20 Min ± 0.70 Min*		33 Degrees 20 Min ± 1 5 Min	
Suggested Dimensions						
r	0.077	1.96	0.077	1.96	0.077	1.96
t	0.006	0.15	0.006	0.15	0.006	0.15
f	0.103	2.75	0.103	2.75	0.103	2.62
e	0.130	3.3	0.130	3.30	0.130	3.3
x	0.040	1.02	0.040	1.02	0.040	1.02
G	1.043	26.54	1.043	26.50	1.043	26.51

*The accumulated error between any 2 teeth not to exceed 4 minutes

† This dimension varies in commercial practice from 0.935" to 0.950" for the feed and intermittent sprockets. Manufacturers have discovered that this dimension may appreciably affect the projector noise level. The choice of an optimum value is somewhat empirical in nature and appears to be influenced by tooth design, the degree of film wrap and the amount of film tension. When film life is of the greatest importance, dimension 0.950" should be chosen. For hold-back sprockets, this dimension varies in commercial practice from 0.932" to 0.940". Good practice requires that the pitch of a hold-back sprocket be less than the pitch of the film.

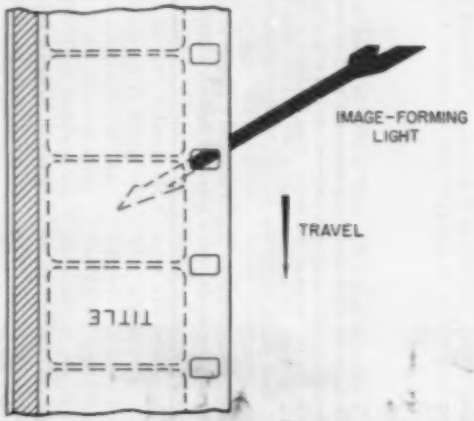
NOTE: When a sprocket is acting as an idler the value of dimension B depends on the particular design of the projector. The range for this dimension in commercial practice is 0.937" to 0.950".

NOT APPROVED

American Standard

16mm Film Perforated One Edge, Usage in Camera

ASA
Reg. U.S. Pat. Off.
PH22.15-1955
(Revision of Z22.15-1946)
*UDC 778.53



Drawing shows film as seen from inside the camera looking toward the camera lens.

1. Position of the Emulsion

Except for special processes, the emulsion shall be toward the camera lens.

2. Rate of Exposure

The rate of exposure shall be 24 frames/sec.

3. Relationship Between Sound and Picture

The apparatus and film shall be so arranged that the sound is placed on the film 26 frames, ± ½ frame, ahead of the horizontal centerline through the corresponding picture. Thus, a given point on the film shall pass the soundhead after it has passed the picture aperture.

Approved July 8, 1955, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers
*Universal Decimal Classification

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70 East Forty-fifth Street, New York 17, N.Y.

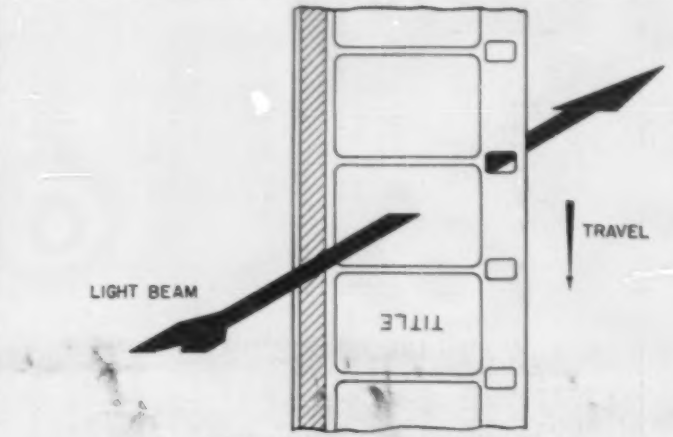
Printed in U.S.A.
ASA\M955

Price, 25 Cents

American Standard

16mm Film Perforated One Edge, Usage in Projector

ASA
Reg. U.S. Pat. Off.
PH22.16-1955
(Revision of Z22.16-1947)
*UDC 778.53



Drawing shows film as seen from the light source in the projector.

1. Position of the Emulsion

Except for special processes, the emulsion shall be toward the projection lens.

2. Rate of Projection

The rate of projection shall be 24 frames/sec.

3. Relationship Between Sound and Picture

The apparatus and the film shall be so arranged that when the film is threaded normally, the soundtrack is scanned for reproduction at a point 26 frames, ± ½ frame, ahead of the centerline through the picture being projected. Thus a given point on the film shall pass the soundhead after it has passed the picture aperture.

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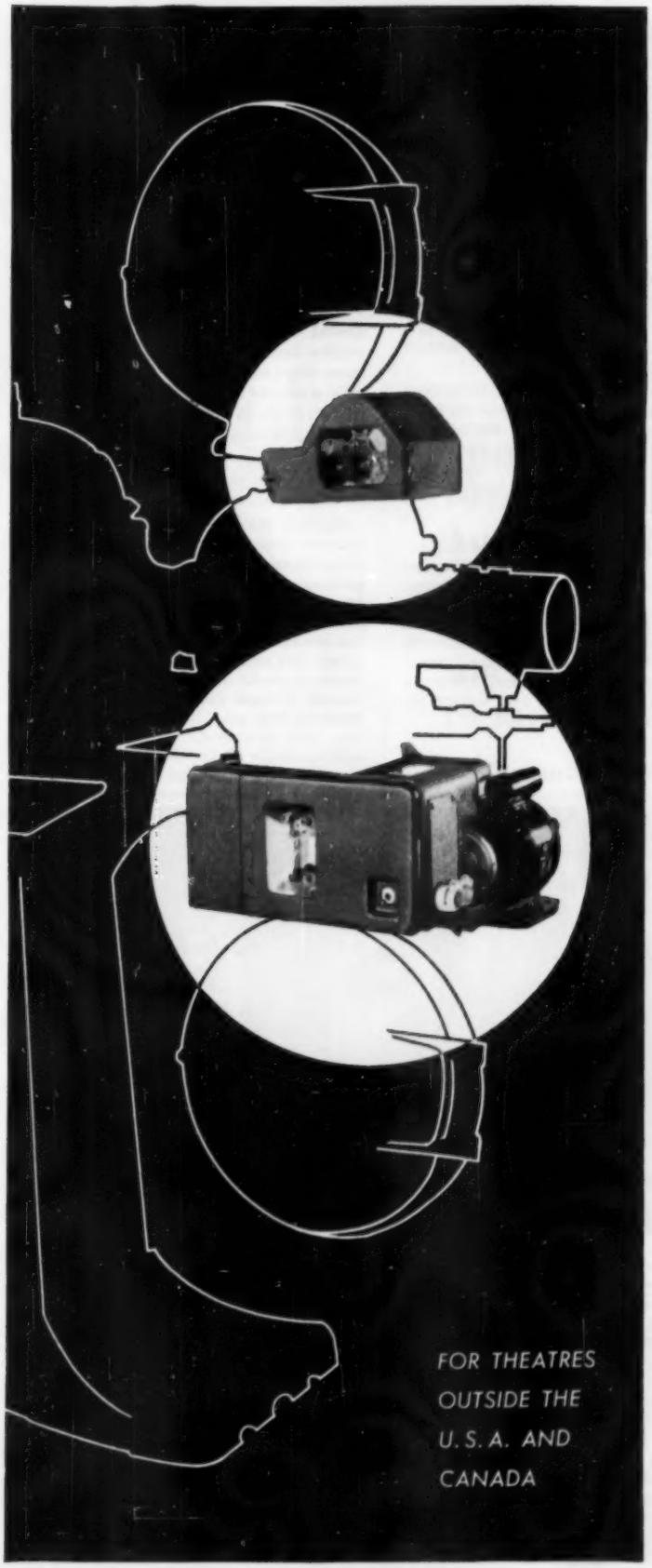

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news and reports

Annual Meeting—1955

Amendments proposed to the Society's Constitution and Bylaws were published on page 448 of the *Journal* for August. These amendments will be considered during the annual business meeting at 10:00 A.M., Monday, Obtober 3, during the 78th Convention at the Lake Placid Club, Essex County, New York.

It is a Bylaw requirement that proposed amendments be published "in the Journal of the Society in the issue next preceding the date of the stated business meeting." Since the business meeting will be held early in October, very soon after circulation of the September issue, it seemed appropriate to make the detailed announcement one month ahead of schedule. This brief notice satisfies the publication requirement of Bylaw XIII, Section 1.

Two Test Film Standards Reaffirmed

These two American Standards on 35mm sound test films were reaffirmed by the American Standards Association in June 1955:

Z22.61-1949, Sound-Focusing Test Film for 35mm Motion-Picture Sound Reproducers (Service Type), Reaffirmed as PH22.61-1949.

Z22.68-1949, Buzz-Track Test Film for 35mm Motion-Picture Sound Reproducers, Reaffirmed as PH22.68-1949.

Action to reaffirm these standards was initiated by the Society's Sound Committee in October 1954 consonant with the ASA 5-year periodic review procedure. This action was subsequently approved by the Sound and Standards Committees, the Board of Governors, ASA Sectional Committee PH22 and the several ASA review organs.—*Henry Kogel*, Staff Engineer.

Third High-Speed Meeting

The Third International Congress on High-Speed Photography will be held in London, September 10–15, 1956, sponsored by Britain's Department of Scientific and Industrial Research.

The most recent developments of high-speed photography as a research tool that can solve a wide range of scientific and technical problems will be discussed and demonstrated at the London Congress. The papers presented will cover the following topics:

Flash sources for high-speed photography and high-speed cinematography;

Mechanical/optical cameras, drum cameras;

High-speed shutters, scanning and image-dissection methods;

Recent applications of all these techniques in research, and particularly in the fields of (a) industrial machine analysis, (b) explosive studies including atomic research, (c) hydrodynamic and aerodynamic research and (d) medical and biological research.

There will also be an international exhibition of high-speed photographic and cinematographic equipment and instruments aids. Those wishing to participate either in the Congress or the exhibition should write: The Third International High-Speed Photography Congress Secretariat, Dept. of Scientific and Industrial Research, Charles House, 5–11 Regent St., London SW1.

Overseas Society Memberships and Journal Subscriptions

Throughout the world, nations have subscribed to the Unesco Coupon Plan which enables their citizens to buy books, publications, films and scientific material in the United States. Through this plan it is also possible to obtain membership subscriptions to learned societies, when the subscriptions are mainly a means of getting the publications of the society. The SMPTE is among the many participants in this program.

In the countries that belong to the Unesco Coupon Plan, national distributing bodies have been set up by the government to sell coupons. Users send Unesco coupons directly to suppliers as payment. For full information concerning the denominations of these coupons, the names and addresses of suppliers, and the exact range of materials covered, write: Unesco Coupon Office, 19 Ave. Kléber, Paris 16, France.

Education, Industry News

E. S. Seeley, recently appointed Director of Engineering for Altec Lansing Corp., was given a farewell luncheon in New York before assuming his new post in Beverly Hills, Calif. Mr. Seeley leaves the position of Chief Engineer for Altec Service Corp., New York.

An electronics engineering specialist, he has worked in both the theatrical and non-theatrical fields of sound. He is credited with much important work connected with the successful introduction of stereophonic sound, particularly contributing to the analysis and solving of problems in magnetic sound film recording and reproduction. His career includes the post of field engineer at Electrical Research Products, and development engineer at Altec which promoted him to chief engineer in 1946. At the request of the National Defense Research Council he was given a leave of absence in 1944 and assigned to work on several important wartime projects at Bell Laboratories.

He has been Secretary of this Society since 1953. Our picture from the luncheon in his honor has, left to right: E. O. Wilschke, Fine Sound, Inc.; Mr. Seeley; F. W. Boettcher, Loew's Inc.; Fred Whitney, SMPTE; and Marty Wolf, Altec Service Corp.'s new Sales Manager.

Throughout the country there is increasing interest and activity in **educational TV,** witness the Friday morning session at the SMPTE Lake Placid convention. Despite the perennial problem of financing the stations, and the difficulty of getting people to convert their TV sets to VHF at a cost of $15 to $75, great strides are being made.

Only two years ago, in April 1952, the Federal Communications Commission reserved 242 TV channels for educational television. Later they increased the number to 251, which is about 12% of all available channels. Today 15,000,000 Americans live within range of noncommercial educational TV stations.

Operated by community organizations and educational institutions, ETV tries to present programs that would supplement the regular commercial shows. They offer those subjects that deal with more limited or local interests than would appeal to mass audiences of commercial network scope. Also, ETV can afford to be more experimental than the expensive, established shows.

Cities like Pittsburgh and Cincinnati have been able to operate on annual budgets of roughly $200,000 to $250,000 with building space and other facilities often donated by a university or the local business community. The National Citizens Committee for Educational Television, Ring Building, Washington 6, D.C., publishes a news bulletin of information and activities in the field. Backed by an Advisory Council of over 100 national organizations, the Committee aids and advises communities where channels have been reserved for setting up ETV stations.

Motion-picture and TV courses offered at Columbia University's School of General Studies are in cooperation with the National Broadcasting Co. The majority of courses are in layman's terms, particularly designed to facilitate the director's, writer's and agency man's understanding of technical equipment. Certain courses, however, stress the techniques of production and cover such subjects as rear projection, synthetic images, optical effects, electronic effects, pyrotechnics, and chemical and mechanical effects.

One course is devoted to the techniques of color television and its special problems. A workshop course is given on film editing, with practice for those who plan to specialize in this field. For advanced students a special production course is given in which the class produces a 16mm documentary film relating to an activity of the University.

For a complete listing and description of courses in the fields of motion pictures and television write: School of General Studies, Columbia University, Morningside Hts., New York 27.

The National Association of Educational Broadcasters, 14 Gregory Hall, Urbana, Ill., recently surveyed the extent of courses offered on television in the United States. The NAEB queried 80 educational institutions throughout the country and received 36 replies showing considerable activity in the field. From the available mimeographed report, we learn such as: In Philadelphia 93,000 students a week used TV for in-school courses. The California Academy of Science in San Francisco reported 1,600,000 regular known listeners in the U.S. to out-of-school, school-level programs. College telecourses, given for credit, were taken by over 15,000 students at the University of Minnesota and by over 25,000 at Iowa State College. Regular listeners to courses of adult level were estimated at between 115,000 and 125,000 by the Board of Education at Cleveland, Ohio. These courses are offered by educational TV stations and also by commercial stations that waive time charges.

The Cinema Collector is the periodical of the Society of Cinema Collectors & Historians, an organization active in recording the history and preserving the materials and equipment of the motion-picture industry. It was organized in June 1953. The *Journal* is a quarterly which publishes such items as these samples taken from the Summer — 1955 issue: "With These Tools — Cinema Is Made," by Irving Browning; "The White Brothers (Motion Picture Pioneers)" by Gatewood W. Dunston. Also, biographical sketches of motion-picture people are given. Information about the Society, its membership and Journal is available from Saul Haber, Secretary-Treasurer, 402 Irvington St., Washington 21, D.C.

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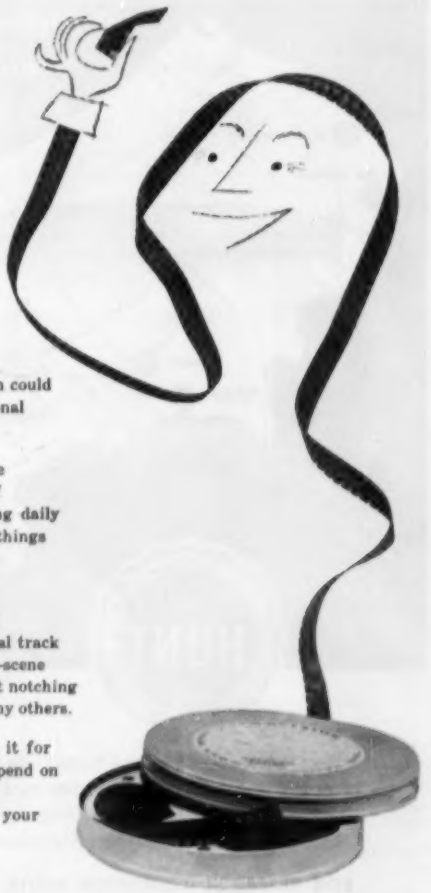

Talk was that other film sizes than 16mm could do better jobs in the industrial, educational and commercial fields.

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current literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

Audio Engineering Society, Journal
vol. 3, Jan. 1955

Record Quality and Its Relation to Manufacturing (p. 19) *A. M. Max*

Frequency-Modulation Noise in Magnetic Recording (p. 26) *R. A. von Behren and R. J. Youngquist*

Correlation of Transient Measurements on Loudspeakers with Listening Tests (p. 35) *M. S. Corrington*

British Kinematography
vol. 27, No. 1, July 1955

The Measurement of Cinema Screen Luminance (p. 9) *H. P. Woods*

International Projectionist
vol. 30, No. 7, July 1955 Pt. II.

Prevention of Damage to Prints (p. 9) *R. A. Mitchell*

A 'Push-Pull' Projector? (p. 13) *J. G. Jackson*

'Cinemaplastic' White Screen Coating (p. 21) *L. Satz*

Institution of Electrical Engineers, Proceedings
vol. 102B; No. 4, July 1955

A Flux-Sensitive Reproducing Head for Magnetic Recording Systems (p. 442) *E. D. Daniel*

Kinematograph Weekly (Studio Review Section)
vol. 459, June 30, 1955

Standards for New Filming Techniques Taking Shape (p. iii)

New Production Techniques the Talking Point (p. vii) *R. H. Cricks*

Kino-Technik vol. 9, July 1955

Englische Ateliertechnik. Ein Bericht über Studioausstattungen (p. 232)

Stockholmer LSO-Tagung im Zeichen der Zusammenarbeit (p. 244)

Stereophonie-Einrichtungen bei der Bavaria-Filmkunst (p. 246)

Aus der Geschichte der Kinematographie. Teil III (p. 252)

Zum 100jährigen Bestehen der Firma Conrad Conradty (p. 255)

Erfolge deutscher Kinotechnik in der Freiluftprojektion (p. 257)

Hunt Chemicals for both color and black and white motion picture processing conform to the photographic specifications of the American Standards Association.

FOR RESEARCH ASSISTANCE WRITE TO:
THOMAS T. HILL, *Director Photographic Research*

FOR TECHNICAL SERVICE WRITE TO:
CHARLES F. LO BALBO, *Motion Picture Technical Advisor*

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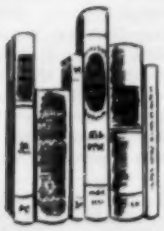
books reviewed



3-D Kinematography and New Screen Techniques

By Adrian Cornwell-Clyne. Published (1954) Hutchinson & Co., 62 E. 83d St., New York 28. 266 pp. 155 illus. 6 × 9 in. 18 shillings.

Mr. Cornwell-Clyne who is well known as an author of articles and books on color photography has succeeded remarkably well in presenting stereoscopic theory and fact in this well-written book. Early historical data are included but very briefly. I feel that some authors have dwelt too much on what has been experimented with in the past. The author has given just about enough space to these features. His review (Chap. 1) of eyes and their perception of depth and the physiological factors involved is concise and clearly presented. However, I should like to take mild exception to his statement (p. 28): "This is known as the breakdown of the accommodation — convergence ratio and *is to some extent a source of eyestrain.*" Eyestrain may exist if the convergence required is great. Probably there is no eyestrain at all if the observer is looking at a projected stereograph requiring long time convergence of about 1 degree. Very brief demands for much greater convergence are not believed to be an impor-

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tant factor in contributing to eyestrain. Nor is some divergence, about one degree or so, believed to set up eyestrain as was the prevailing theory some years ago.

The author (in Chap. 2) comprehensively covers the stereoscopic motion picture in general and goes into sufficient detail effectively to describe and illustrate most of the methods proposed for projection and viewing including "juxtaposed pictures on the screen," "superimposed pictures" such as in the Anaglyph and polarized light systems, "eclipse systems" which depends upon alternate projection and obscuration of left- and right-eye views, "autostereoscopic" (free vision) systems employing grids of various types and lenticular screens.

Techniques of Taking and Projecting (Chap. 3) explores the fundamental geometry of the stereoscopic process and some of the hazards encountered in projection by the methods in common use.

Chapter 4 summarizes briefly but adequately the stereoscopic motion-picture camera and most of the expedients which have been employed in search of suitable stereoscopic camera equipment.

Chapters 5 through 8 cover the "wide screen" and "stereophonic sound" and they cover them very well indeed. Of particular value is the information about "CinemaScope" and "Cinerama." This section is full of data on ratios and dimensions and is up to date enough to serve as a general reference source.

Chapter 9 deals with "cartoons in 3-D." Enough information is given to serve as a springboard from which an individual interested in this fascinating subject can take off.

The remainder of the author's text is devoted to 3-D and wide screen with 16mm equipment, a review of 3-D in Continental Europe, and a healthy analysis of what has been wrong, what to do about it, and the potential future of 3-D tied up with the wide screen.

Of particular value to the serious worker in the stereoscopic art are the two appendixes, the first "A Mathematical and Experimental Foundation for Stereoscopic Photography" by Dr. Armin J. Hill (reprinted from the *Journal of the SMPTE*, vol. 61, no. 4, Oct. 1953); the second, "Notes on the Basic Geometry in Viewing 3-D" by S. H. Groom. These appendixes provide the best mathematical information yet available and is presented in a clear-cut and easily understood manner.

All in all, Mr. Cornwell-Clyne has written what ranks tops among the many books published on stereoscopy. His style is lucid; the illustrations are many and of first-notch quality.—*John A. Norling*, Loucks & Norling Studios, Inc., 245 W. 45 St., New York 19.

Advances in Electronics and Electron Physics, Vol. 6

Edited by L. Marton. Published (1954) Academic Press Inc., 125 E. 23 St., New York 10. 538 pp. 203 illus. 6 × 9 in. Price $11.80.

In this, the sixth volume of the well-known *Advances in Electronics* series, the title has been changed to include "Electron Physics." This does not mean that the character of the series has been changed, but indicates more properly the scope and nature of the papers. In fact, in the present volume there are no papers on circuitry, and there is as much space devoted to the solid state as to vacuum and gas tubes.

Books of this type generally contain articles of varying level, some suitable for a novice's introduction to the subject, others requiring some background on the part of the reader. This volume is no exception. All the papers were meant to be critical reviews of their subject, and usually a considerable degree of success has been achieved in this direction.

There are three papers related to various aspects of magnetism. E. Abrahams in "Relaxation Processes in Ferromagnetism" presents a succinct, almost nonmathematical, summary of the various ferromagnetic relaxation effects. In addition, the author points out some of the unsolved problems remaining. The reviewer suspects that the beginner would find the going difficult in this article. On the other hand, the other two papers on magnetism, "Physical Properties of Ferrites" by J. Smit and H. P. J. Wijn and "Paramagnetism" by J. Van der Handel, all Dutch authors, generally provide most of the background needed for an understanding of the more difficult sections. The paper on ferrites considers the structure, magnetic properties, methods of production and the use in electronics of these important compounds. The article on paramagnetism begins with an explanation of the atomic bases, describes experimental methods of measuring the susceptibility, and discusses theoretical explanations of the observations. There is a description of the effect of the inner crystalline field on the paramagnetic behavior of some salts, followed by sections on paramagnetic relaxation and paramagnetic resonance. Adiabatic demagnetization and some aspects of antiferromagnetism conclude the paper.

Microwave techniques, used to study the conduction of metals at low temperatures are described by A. G. Pippard in "Metallic Conduction at High Frequencies and Low Temperatures." Since the study of this field has been carried out by a small number of research workers since the war, the summary of results is quite complete. Results, and their interpretation, concerning the surface impedance of the so-called anomalous skin effect and for the superconducting state are adequately presented.

W. M. Webster's paper "A Comparison of Analogous Semiconductor and Gaseous Electronics Devices" reviews the fundamental theory and the actual performance of those semiconductor devices that are most analogous to gas tubes. The first section considers the fundamental conduction processes in semiconductors and gases and discusses the operating principles of junction devices. In the second section, existing semiconductor devices are compared to their equivalent gas tubes. The third section discusses the theoretical limits to voltage, current density and power dissipation in junction devices.

"Space Charge Limited Currents" by H. F. Ivey is an authoritative, extensive detailed account of the subject. The paper discusses not only the problems of current flow for zero initial velocity, for homogeneous initial velocity and for a maxwellian distribution of initial velocities in

vacuum tubes of various geometries, but also the problem of space charge in gases, in electron beams, in double diodes and cavities, and in semiconductors. The author, who has made numerous contributions to the field himself, makes this well-written review even more useful to the worker in the field by correcting a number of mistakes in the original papers of several authors.

The clearly written article by R. G. E. Hutter on "Travelling Wave Tubes" is almost complete and up-to-date, including most of the newer techniques and viewpoints which have proved to be of value. The presentation is largely mathematical, and to some extent more physical explanation of the operation of the tubes would have been desirable. The paper is primarily of value as a good summary for those with some familiarity of the field.

Finally, M. E. Haines in "The Electron Microscope—a Review" describes in detail researches concerning the instrument, and not its applications. Very little mathematical detail is included, the article being mainly explanations of results. It is of particular value to the user of the instrument.—*A. H. Morrish*, University of Minnesota, Minneapolis, Minn.

New Horizons in Color

By Faber Birren. Published (1955) by Reinhold Publishing Corp., 430 Park Ave., New York 22. i-vii + 200 pp. incl. 150 illus., 6 in full color, 2 pp. of color chips. 8¼ × 10, in. Price $10.00.

This book treats of color harmony and aesthetics, with particular regard to architecture and decoration. The text has many illustrations, and is easy to follow. There is an interesting story on the history of color in architecture, Numerous references to other works of a scope similar to that of the text are given in an appendix and a bibliography. There is no specific coverage of either motion-picture or television color practice, and hence the book's usefulness to Society membership may be very limited.—*Bernard D. Plakun*, General Precision Laboratory Inc., Pleasantville, N.Y.

How to Draw in 3rd Dimension

By David Gordon. Published (1955) William-Frederick Press, 313 W. 35 St., New York 1. 16 pp. Color illus. Paper cover. 8½ × 11 in. Price $2.00.

As there is very little instructional copy in the 16 unnumbered pages of this booklet. it might be well to cover the material as encountered by a reader.

Mr. Gordon evidently takes for granted that the reader understands a great deal more about 3D drawing than a purchaser of the booklet looking for just such information would actually have. After following the four points under "Drawing instructions for third dimension," the reader will obtain the result promised, *but* unless he does a lot more outside reading, he will not know enough about the WHY of the process to enable him to do other drawings equally well. There is much left unsaid.

The relationship and ratio of picture plane to infinity, and picture plane forward to practical limits are not clearly defined for aspiring 3D artists, and although Mr. Gordon gives directions for making larger drawings in "Drawing for Various Sizes," he does not show one how to reduce or process them for use on standard stereoscopes and viewers that he mentions in "Hints for your own drawings."

Search of the patent office will show the reader, and Mr. Gordon, mechanical drawing boards or devices which will almost automatically mark off the offset points necessary for the number two drawing using incorporated dimensional guide marks. The devices shift the paper while measuring the shift to or from infinity, and this procedure is much more accurate than any manual method.

The "Gordon Viewing System" describes several variations of a method of viewing objects for 3D effects. One would have to see these devices for honest comment, but personally, and from Mr. Gordons descriptions, I cannot see audiences using these instruments for practical purposes. It seems that anaglyph and polaroid processes are far more economical and practical.

In 29 lines of 10 point copy Mr. Gordon gives a "Short History of Stereo" which mentions a very few of the researchers in 3D. In his "The Future of Dimensional Pictures," Mr. Gordon presents his "the Gordon proposal (patent applied for) of a 3D effect for film and TV without viewing glasses involves predominating alternating frames, using the eye's retention of image to a *single* film strip." I believe every worker in stereo has tried to photograph alternate frames for right-eye, left-eye retentional images. It is possible that Mr. Gordon has overcome the problem involved in such a process wherein the right eye in its retention of images must always skip the alternate frames shown for

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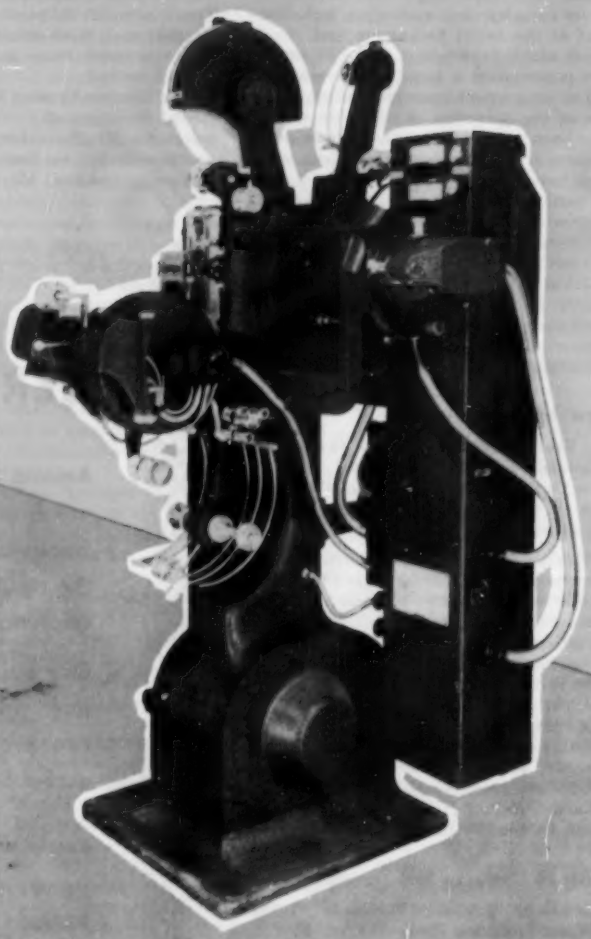

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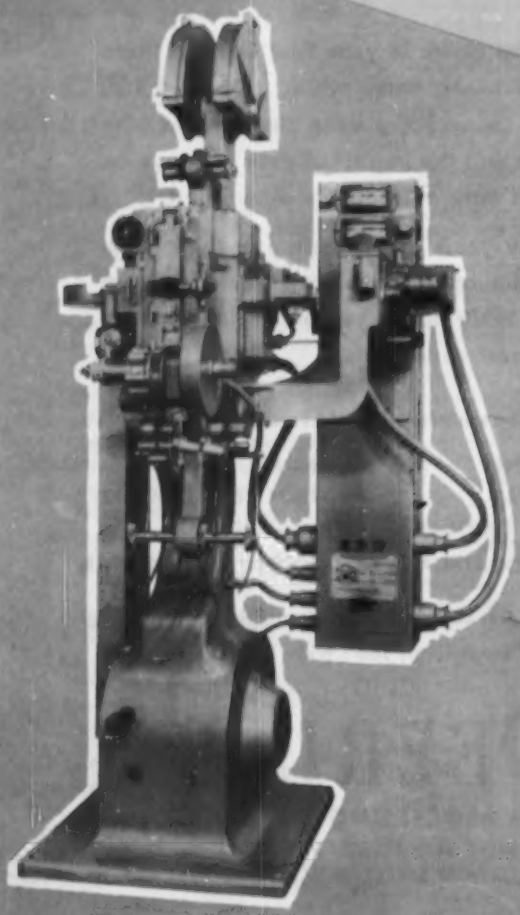

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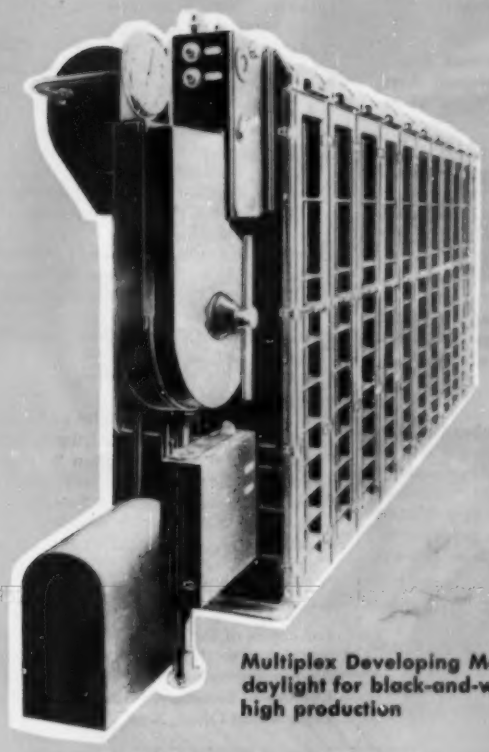

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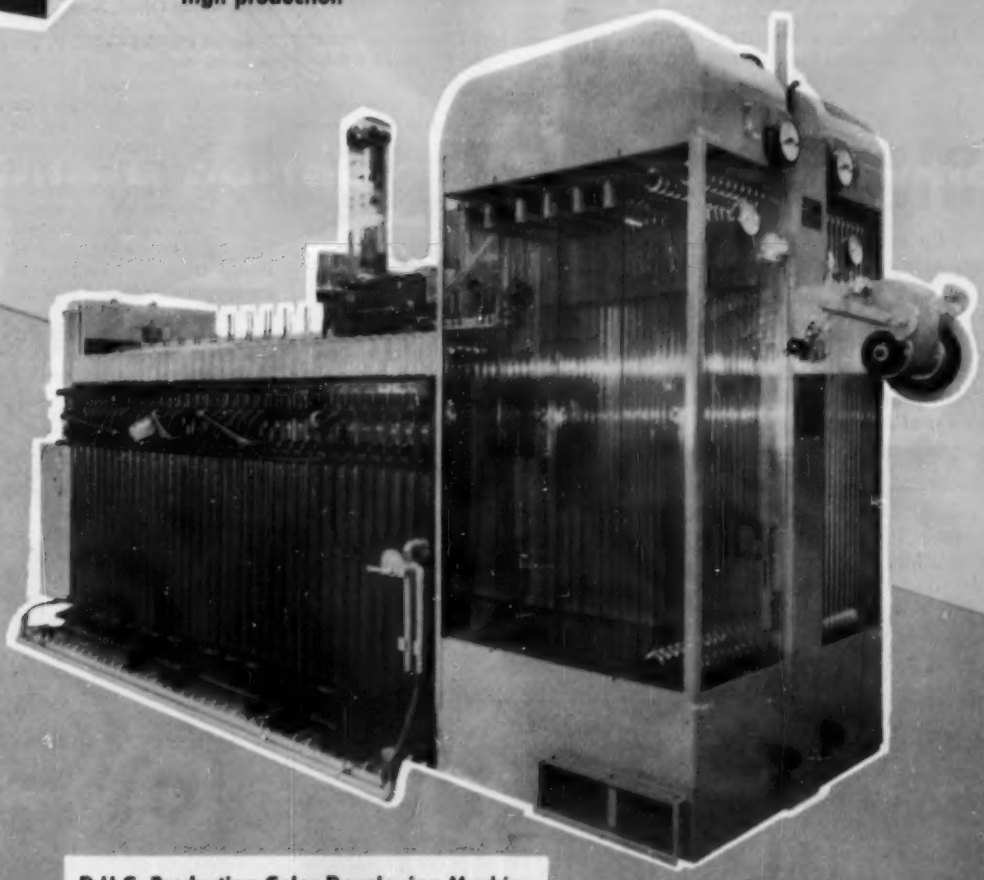

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the left eye—either mechanically, or by polarization, or what have you. Both eyes can never fuse opposite single-eye pictures into a single image, especially without an aid of some sort.

The chapter on "Stereo Uses" is really a page of sketches showing a few of the existing devices used in various stereo methods.

I do not believe the reader will gain much 3D information from this booklet.—*Prof. Ernest F. Hiser*, University of Oklahoma School of Medicine, Oklahoma City 4, Okla.

Projectionist's Manual

Published (1954) by the Government Printing Office, Washington, D.C., 99 pp. Catalog No. D208.6:P94. Price 65 cents.

This reference manual, originally prepared for Navy projectionists, is equally of use to home operators and is of interest to many audio-visual equipment users. It begins with illustrations of the various kinds of projection equipment — 16mm projectors, the still picture projector, and tape recorders. The subjects covered include the setting up and operation of projection equipment; proper use of equipment; preventive and corrective maintenance for film and equipment and other important questions in the mind of the practicing projectionist. There are numerous detailed illustrations and instructions, plus a helpful glossary of terms.

The Audio-Visual Equipment Directory. 2d Edition

Published (1955) by the National Audio-Visual Assn., Inc., 2540 Eastwood Ave., Evanston, Ill., 179 pp. Illus. 8¼ × 11 in. Price $4.00, $3.50 if check sent with order.

This directory lists 365 models of 16mm motion-picture projectors including optical and magnetic sound projectors and silent machines. Specifications are given for each model including date of manufacture, list price, serial number, lens, lamp, reel capacity, rewind information and parts available. Also covered are filmstrip and slide projectors, sound recorders and playbacks, screens, film library equipment and audio-visual accessories.

A 25th Anniversary Number of the *Journal of the Biological Photographic Association* is now in preparation. The first number of the BPA *Journal* appeared in September 1932 and it has continued to be published as a quarterly ever since. The papers to be published in this number are as follows:

"Anthony Van Leeuwenhoek — A Review of His Life and Work," by Sidney Shapiro
"Photocolposcopy" by Leopold Z. Goldstein, M.D.
"Radiographs and Specimen Montages" by Martha Brunings and John J. Beiter (illustrated in color)
"Color Photography of Fluorescent Plant Materials" by Arthur R. Spurr (illustrated in color)
"Making 35mm Transparencies by Projection" by David Danziger
"Differential Optical Staining of Colorless Living Organisms In Macrophotography" by Robert F. Smith (illustrated in color)
"The Use of Cine Extension Tubes for Cinematography of Small Objects" by Mervin W. LaRue, Sr.
"A Simple Preparation of Helminthological Specimens for Photomicrographic Purposes" by Walter Petana
"Stereophotography Utilizing Available 2¼ in. × 3¼ in. and Larger Equipment" by Kenneth D. Tompkins and John J. Beiter
"Photography of the New Born" by M. W. Bolleter
"Standards In Gross Photography" by Julius Halsman
"Panel On Photomicrography of Medical Specimens" (Oscar W. Richards, Moderator; John J. Beiter, John V. Butterfield and Julius Weber, panel members)
"Medical Photography As a Boon to Trial Lawyers" by Albert Averbach
"Little Known Applications of the Microscope in Science and Technology" by Dr. Fritz Braeutigam (translated by Gerard M. Lindley)

For copies of the Journal or other matters pertaining to the Biological Photographic Association write: Miss Jane H. Waters, Executive Secretary, Box 1668, Grand Central Post Office, New York 17.

Soviet Physics — JETP, a translation of research reports in the Russian language *Journal of Experimental and Theoretical Physics* will be published by The American Institute of Physics, 57 E. 55 St., New York 22. Funds for the first year's operations were supplied by the National Science Foundation of the Federal Government.

The new journal will appear every two months, the first issue to come out in October. The editor is Prof. Robert T. Beyer of Brown University. Editorial offices are being supplied by Brown University. An Advisory Board on Russian Translations has been appointed by the American Institute of Physics.

The annual cost, six issues, has been announced at $30.00 for U.S. and Possessions, Canada and Mexico; $32.00 for all others.

The Development of Automation in Metalworking is the title of a paper given recently by Anderson Ashburn, of *American Machinist*, before the ASME. The paper traces the development of automatic production techniques, including the principles of standardization, interchangeability, the continuous assembly line and the transfer machine. Much of our present automation, the author says, is limited to high volume and inflexible design, but engineers are seeking to restore the wide flexibility of the Spencer cam to automated setups. Most of the effort in this direction is toward tape or some form of numerical control, and noncircular gears have been produced commercially on a shaper controlled by film.

Written discussion on this paper is invited and will be accepted by ASME up to July 1, 1956. Copies of the paper, No. 55-SA-62, may be obtained at 50 cents each from Order Dept., ASME, 29 West 39th St., New York 18.

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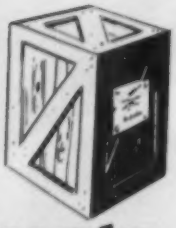

new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

The Century-Izenour, or C-I board, put out by Century Lighting, Inc., 521 W. 43 St., New York 36, is reported the first all-electronic control board for stage and television lighting control, and is manufactured solely by Century. The two main elements of the C-I Board are the control console with attached preset panel and the tube bank. A unique feature of the system is the automatic, motorized, variable-speed fader. These are described in an illustrated brochure available from Century. **Also**

from Century Lighting is the new C-lector, a remote control, preset switching system. The C-lector permits the operator to select any one of ten or more preselected lighting setups for from one to more than a hundred lights.

Membership Certificates (Active and Associate members only).. Attractive hand-engrossed certificates, suitable for framing for display in offices or homes, may be obtained by writing to Society headquarters, at 55 West 42d St., New York 36, Price: $2.50.

A 16mm CinemaScope lens that will adapt to all standard 16mm projectors, and listing at $124.50 with an adapter, has been announced by the Bausch & Lomb Optical Co., Rochester, N.Y. At present it is available in 2-in. focal length. When used at the same throw distance as a regular lens, the B&L CinemaScope lens will produce an image twice as wide. The lens requires no brackets or supports, is 6¼ in. long and weighs 7¼ oz.

COLOR TEST FILMS AND SLIDES FOR TELEVISION STATIONS

SMPTE now has available 35mm and 16mm color television test films and slides designed for TV station use under specifications set up by the SMPTE Television Committee—representing the quality of color material obtainable from Ansco, Technicolor and Eastman prints.

☐ The picture-only films have three sections of five scenes each.

☐ Gray scale at start of first scene can be used in set-up or for adjusting signal generating equipment so that the chrominance subcarrier vanishes with given set-up.

☐ Same high quality picture material in both films and slides.

☐ Slides include one black-and-white chart of the alignment and resolution target used in standard television test films.

☐ All scenes illuminated for shooting with a lighting ratio of approximately 2:1; i.e. key light was twice fill light, measured in foot candles.

35mm Color TV Test Film—approx. 700 ft.

16mm Color TV Test Film—approx. 280 ft.

Set of 10 2 × 2 in. Slides

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55 West 42nd Street, New York 36 Tel: LOngacre 5-0172

Safety...10 miles high!

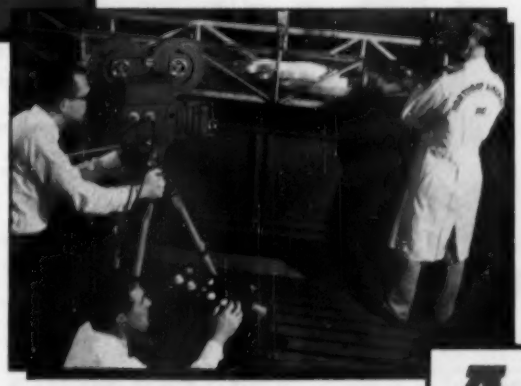
...assured by Turco's Flaw Detection Method filmed at Northrop Aircraft with Auricon 16mm Sound Cameras

Cralen Enterprises, Inc., filming William Cox of Northrop Public Relations, as he interviews Robert Love, jet ace, after test flight in Northrop F-89 all-weather interceptor.

The full story of flaw detection in metals with Turco "Dy-Chek" Dye Penetrant is the subject of a new Training Movie in sound and color, filmed at Northrop Aircraft with Auricon 16mm Sound-On-Film Cameras.

The film shows how "Quality-Control" checks metal parts for the Northrop F-89 all-weather jet interceptor right on the production line, with Turco's "Dy-Chek" inspection process!

Turco's new Training Movie on "Dy-Chek" Flaw-Inspection Process, is shown during filming at Northrop Aircraft, with Craig Curtis (at camera) and Lennie Blondheim, both of Cralen Enterprises, Inc., Hollywood, California.



This film is another example of how Training Movies and Industrial Motion Pictures can be produced with precision and fidelity using Auricon 16mm Sound Cameras. Professional Auricon Built-in Features, include Self-blimping Camera design, Synchronous Motor Drive, Auricon-Electromatic Take-up, etc. Many producers and cameramen have named Auricon..."the finest 16mm Sound Camera ever built!"

Auricon Cameras are sold with a 30-day money-back guarantee. You must be satisfied! Write for free illustrated Auricon catalog.

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MANUFACTURERS OF SOUND-ON-FILM RECORDING EQUIPMENT SINCE 1931

Circarama, an unusual motion-picture technique that projects a picture on a circular, overhead screen was introduced this past July by the American Motors Corp. as a part of the Tomorrowland section of Disneyland (left).

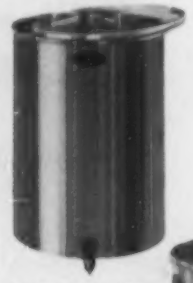
This technique consists of a synchronized battery of Eastman 16mm Model 25 projectors which simultaneously focus color motion pictures on 11 individual screens arranged in a complete circle. Figure at right shows the series of cameras coordinated to shoot the film.

Spectators stand in the middle of a specially built theater viewing the continuous action on a screen 8 ft high and 40 ft in diameter, as a series of images moves consecutively across the 11 screens. This film process constitutes the first known application of sound motion pictures to the circular screen.

Circarama recalls to mind descriptions of Grimon-Sanson's invention displayed at the Paris Exposition of 1900 — Cineorama. This is also referred to as the "French balloon theater" because it gave the viewers the illusion of rising into the air in a large air-filled balloon. Sanson used 10 synchronized cameras and projectors on a screen 30 ft in height. He completely surrounded the spectators with a single scene projected in color.

The research was a combined effort by technicians of the Eastman Kodak Co., the Disney Studios, and the Ralke Co. in engineering the camera and projection devices for Circarama. The decision to use eleven cameras was made because that number kept screen curvature down to a minimum, thus doing the best job of eliminating distortion. Also, an odd number of cameras was necessary because of the arrangement of projectors which are set up behind the screens and project between panels to the screen directly opposite.

Beckman & Whitley, Inc., research camera manufacturers of San Carlos, Calif., have organized a new department to make high-speed photographic services available to the research fields. The new facility is for use in the analysis of application problems, for custom projects, and for evaluating projected installations where there is not sufficient work to warrant owning full-time



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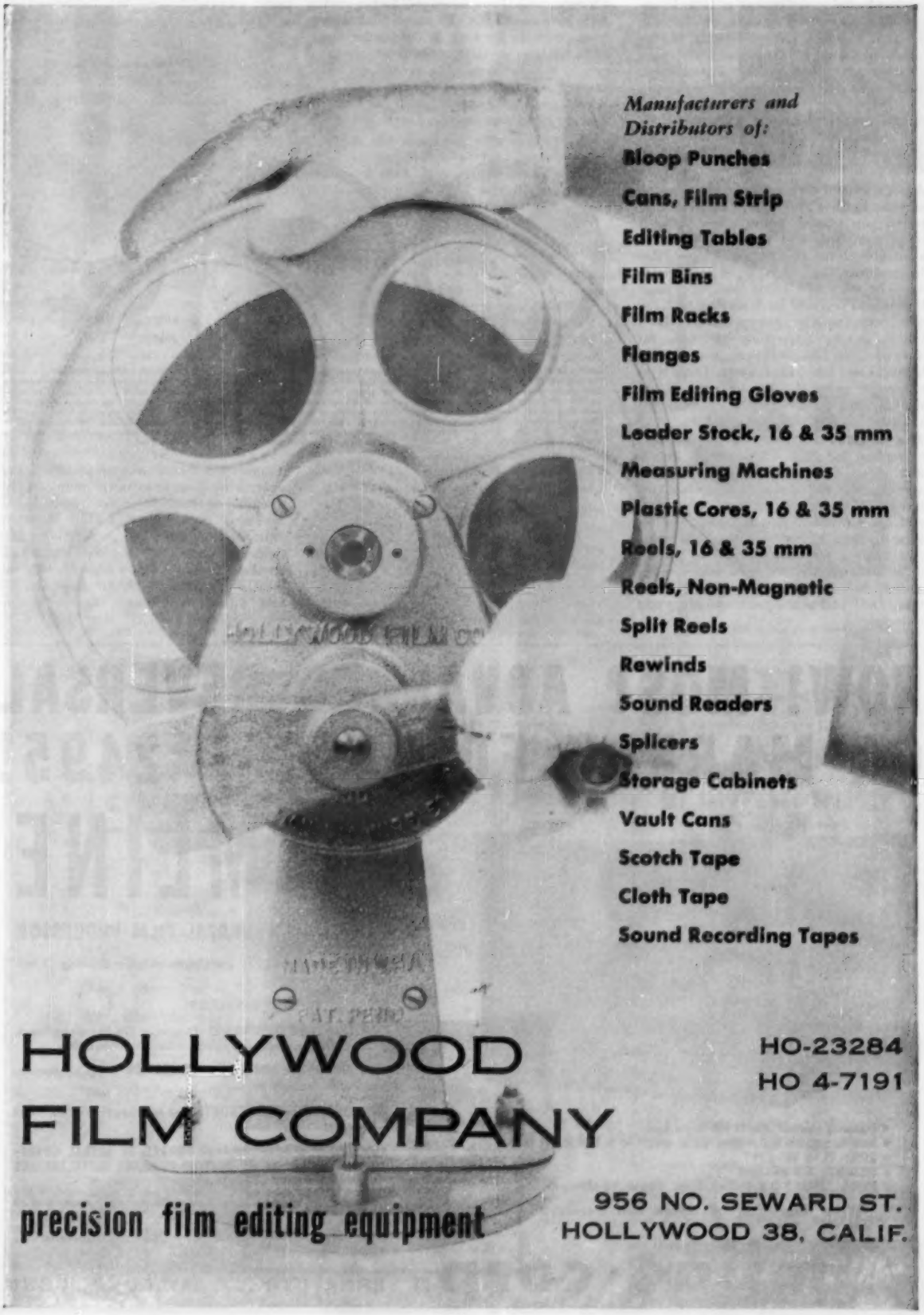
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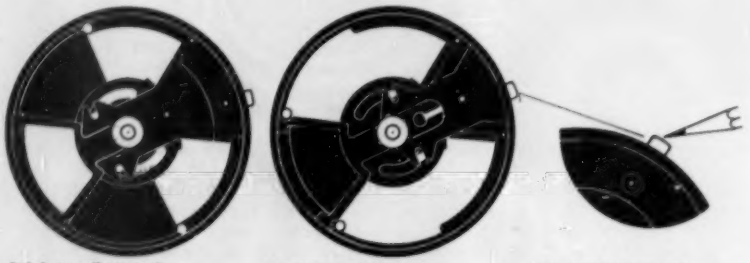
A pocket-sized directory of film industry services in New York City, such as laboratories, film editors, sound stages, etc., is being compiled, and will soon be made available at no charge, by Circle Film Laboratories, Inc., 33 W. 60 St., New York 23. The data are being compiled from the returns received on a mailing of 2,200 questionnaires. The directory is for distribution among advertising agencies, industrial firms, film producers, program distributors and television stations. There is no charge for either the directory or a listing therein, and no advertising has been included.

The RCA-200 is a new projector designed to replace the RCA-100 for both indoor and drive-in-theater use. Water-cooled aperture-unit mechanisms are available for increased illumination without undue heat, and other features include: main and reverse shutters housed together in a single rear casing, but with the reverse shutter independently driven; 4-in. lens mount; sealed ball bearings; simplified film-threading; and automatic loop-setting pad rollers.

Photographic Production of Slides and Film Strips is the title of a new Kodak data book outlining the steps in the production of a filmstrip or slide series from photographs and flat copy. The procedures explained are for low-cost presentations, in small quantities, made with ordinary photographic equipment. There are detailed descriptions of the techniques in making master prints, photographing flat copy, making black-and-white positives, preparing color transparencies and addition of titles. Copies of this book are available through all Kodak dealers, at 50 cents each.



Switch on at silent speed
The Super-40 Shutter automatically presents three shutter blades. With three light interruptions per shutter revolution . . . and 16 frames-per-second operating speed . . . the Pageant develops 48 light interruptions per second. Comfortable, flicker-free projection with standard illumination.

Switch to sound speed
The Super-40 Shutter shifts automatically to two blades, and screen illumination is increased by more than 40%! Yet at 24 frames-per-second sound speed, there are still 48 light interruptions per second . . . and your movies, though amazingly brilliant, are still comfortably free from flicker.

Or lock in 3-bladed position
For those occasions when you don't need the extra brilliance of a two-bladed shutter — projection in very small rooms, for example — a special latch lets you lock the shutter for standard illumination. And when you wish to return to automatic control, just release the locking lever.

The Super-40 Shutter is a new Eastman Kodak device designed for 16mm Kodascope Pageant Projectors. It shifts automatically between two- and three-bladed positions, and gives increased screen illumination without flicker for both sound and silent motion pictures. The new shutter meets the demands of projector manufacturers for additional projector illumination needed to make possible larger screen sizes used in modern 16mm projection. Three Pageant audio-visual models are now equipped with the Super-40 Shutter: AV-073 (7-w, 8-in. speaker, single case), $425; AV-153 (15-w, 12-in. speaker, 2 cases), $530; AV-153-S (15-w, 8-in., single case), $455. All projectors are sold through Eastman Kodak audio-visual dealers.

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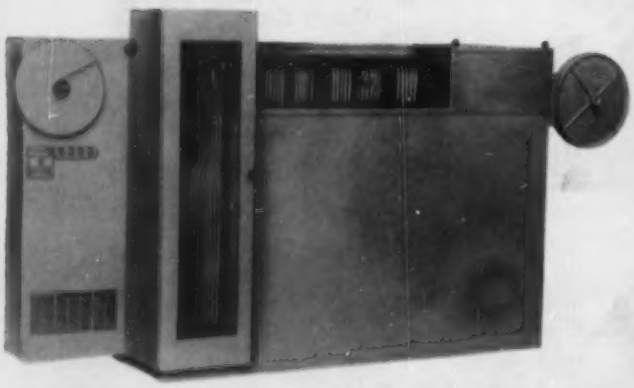

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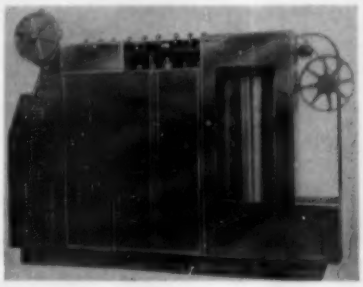
A new wow and flutter meter, expressly designed to meet IRE, SMPTE, ASA standards on sound recording and reproducing methods for determining flutter content is now available from Donner Scientific Co., 2829 Seventh St., Berkeley 10, Calif. For use in engineering laboratories, broadcast stations, motion-picture studios and theaters, and service shops, applications include measurement of both high- and low-frequency variations with mechanical, optical or magnetic recording and reproducing equipment. Specifications are: accuracy of flutter readings, ± 5%; input impedance, 500,000 ohms; test signal frequency, 3000 cycles/sec ± 5%; minimum average input signal level, 0.1 v rms; dynamic limiter range, approx. 40 db; sensitivity, linear scales on 4-in. square meter for full scale indications of 3.0%, 1.0% and 0.3%; response rates, 0.5 to 10 cycles/sec (wow), 10 to 300 cycles/sec (flutter), 0.5 to 300 cycles/sec (overall); dimensions 7¾ in. high by 10¾ in. wide and 8¼ in. deep; weight, 15 lb.

Labmaster, a simplified motion-picture film processor of 16mm film, has been introduced by Houston Fearless Div., Color Corp. of America, 11803 W. Olympic Blvd., Los Angeles 64. The Labmaster is daylight operating, and it features an "in-line" design which permits installation against a wall. Film is transported by a friction clutch drive and speed of operation is variable from 10 to 35 ft/min, depending on type of film, energy and temperature of solutions. Developer and fixer tanks have temperature control, and recirculation is provided for the developer. All tanks are equipped with bottom drains. Other features include an improved air squeegee, built-in air compressor, spray combination wash, infrared strip heaters in dry box, and filtered forced air dry box with exhaust duct outlet.



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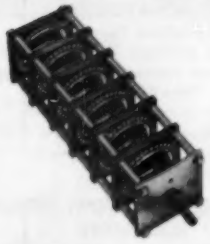

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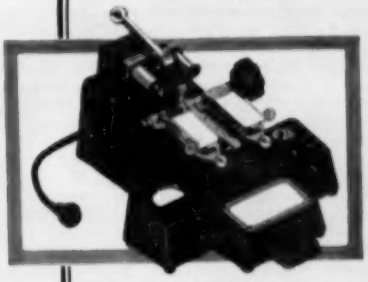

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Theater Engineering Manager. Seeking position with large theater circuit or equipment manufacturer. Can assume all responsibility involved in planning, procurement, installation and service of sound and projection equipment; also stage, seating, air conditioning and heating, construction, maintenance entire physical theater and real estate properties. Sales and export experience in High Fidelity. B.S. in E.E. Member SMPTE and licensed professional engineer State of N.J. Over 20 yr experience. C. J. Bachman, 111 Halsted St., E. Orange, N.J.

TV/Motion-Picture Coordination. Registered professional consulting engineer with unique combination experience in TV/film and live production, broad administrative and demonstrated technical ability, can bring technical knowledge and production experience to bear on commercial film production and do shirt-sleeve work. Experience includes executive TV work in major agency, writing and producing commercials, and national networks. Author of 3 books and scores of articles; TV consultant to universities; also professor teaching *all* phases TV and TV films; able to get along with people; well-known in industry, speaker, active in industry committees, NTSC, Senior Member IRE, SMPTE. Age 39. Write: c/o Hewitt, 4515 Saul Rd., Kensington, Md.

16mm Cameraman familiar with all phases of industrial production wants permanent position. Write Robert M. Jackson, 419 W. Polk, Apt. 4, Houston 19, Texas.

16mm Cameraman. 15 yr experience; age 41. Last 7 yr as head cinematographer in medical college shooting color exclusively; editing and some animation, also all-round still and lab work, black-and-white and color. Seeking permanent position; complete résumé from: Robert A. Leonard, 2100 10th Ave. South, Birmingham 5, Ala.

TV Closed Loop Development. Personal equipment and services available for experimental work on closed loop camera chains and 16mm film projection TV systems. Complete camera chain (using 5820 Image Orthicon) including timing generator, RETMA sync generator, line amps, regulated supplies, slide and 16mm, S.O.F. modified projectors, slide and film, standards and pix monitor. All composite and pulse outputs meet precise RETMA standards. Actively engaged in the art since 1936 with pioneer company, well grounded in compatible color TV techniques. Desire to become associated with small but virile laboratory where the above equipments, solid know-how and can-do will be recognized and remunerated accordingly. Harold A. Lockwood, c/o State Hospital, Logansport, Ind.

Television Floor Manager. Young married man desires TV floor position with aggressive station. Recently completed film seminar at New School (New York). Show business background; acting, directing. Will locate anywhere. Write: Joseph R. Masefield, 15 Berkeley Place, Brooklyn 17, N.Y.

Positions Available

Audio Laboratory Engineering Assistant. Will set up, operate and maintain audio equipment in Audio Division of major consumer testing organization; will construct auxiliary equipment as required; will assist division head and others in testing audio equipment sold to public. Required—degree in electrical engineering or equivalent experience; also 3–4 yr experience in audio equipment operation and maintenance; some familiarity with theory and mathematics of audio electronics and acoustics. Salary $100 up depending on individual. Send résumé to Personnel Director, Consumer Reports, 17 Union Sq. West, New York 3.

Partnership available to experienced motion-picture technician in small film concern. Desire and ability to be "own boss" imperative. Requisites: Recording, editing, camera, special effects, animation skills—initiative, drive, intelligence, flexibility and inventiveness. Sales ability and administrative aptitude essential. Resume in letter form stating pertinent facts and full expression of personal and vocational objectives will be accorded strict confidence. Graphic Films, 104 West 43 St., New York 36.

Film Technicians. Motion-picture laboratory experience required—top pay offered to timers, developers, printers, negative and positive workers, cleaners, projection inspectors, chemists, machinists. Movielab Film Laboratories, Inc., 619 West 54th St., New York 19.

Film Editor. Demonstrated creative and technical ability, minimum 1 yr of editing experience. Work in other phases of motion-picture production helpful, but not necessary. Employment will be with college motion-picture unit engaged in production of educational films for TV and classroom use. Basic starting salary approximately $70 per week, commensurate with ability and experience. Send resume of background and experience to Norman E. C. Naill, Motion Picture-TV Service, Virginia Polytechnic Institute, Blacksburg, Va.

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The Society offers for sale its Magnecorder ¼-in. magnetic tape equipment, consisting of one PT7-P three-channel recording/playback amplifier which contains separate recording and reproducing amplifiers and a single power supply for both. The PT63-A recorder mechanism has erase, record and playback heads and tape speed is 15 or 7½ in./sec. Both units are housed in leatherette-covered cases equipped with carrying handles. This equipment is in practically new condition, having been used solely by professionals for recording at Society conventions. No microphones are included. Price: $400.

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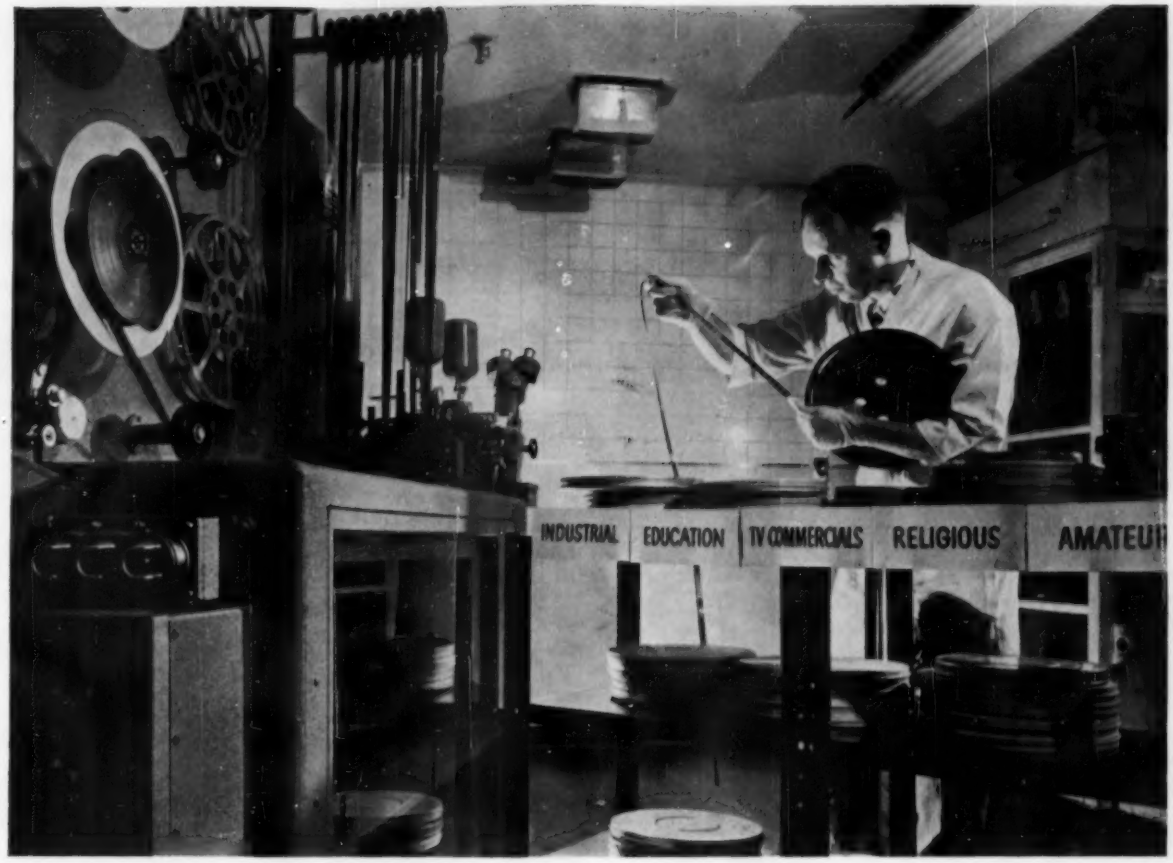

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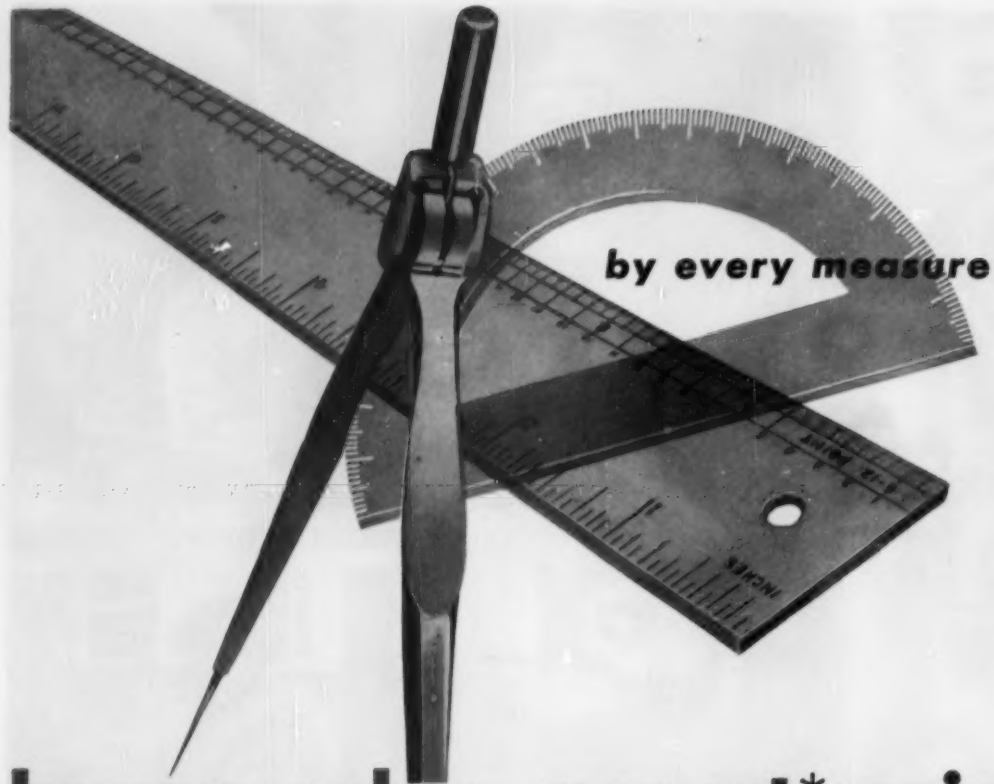

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3-D Kinematography and New Screen Techniques, by Adrian Cornwell-Clyne, reviewed by John A. Norling; *Advances in Electronics and Electron Physics, Vol. 6*, edited by L. Marton, reviewed by A. H. Morrish; *New Horizons in Color*, by Faber Birren, reviewed by Bernard D. Plakun; *The Audio-Visual Equipment Directory-Second Edition*, published by the National Audio-Visual Association, Inc.; *Projectionist's Manual*, published (1954) by the Government Printing Office; 25th Anniversary Number of the *Journal of the Biological Photographic Association*; *Soviet Physics–JETP*; *The Development of Automation in Metal Working*.

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Meeting Calendar

National Electronics Conference, Oct. 3–5, Hotel Sherman, Chicago.
78th Semiannual Convention of the SMPTE, Oct. 3–7, Lake Placid Club, Essex County, N.Y.
American Institute of Electrical Engineers, Fall General Meeting, Oct. 3–7, Morrison Hotel, Chicago.
Photographic Society of America, Oct. 5–8, Sheraton-Plaza Hotel, Boston, Mass.
Optical Society of America, Oct. 6–8, Hotel Wm. Penn, Pittsburgh, Pa.
Theatre Owners of America, Oct. 6–9, Biltmore Hotel, Los Angeles.
Audio Engineering Society, Oct. 12–16, Hotel New Yorker, New York.
American Standards Association, 37th Annual Meeting and Sixth Annual Conference on Standards, Oct. 24–26, Washington, D.C.
Fifth Industrial Electric Exposition, Nov. 1–3, Hotel Wm. Penn, Pittsburgh.
National Electrical Contractors Association, Annual Convention, Nov. 2–5, Waldorf Astoria, New York.
Theatre Equipment and Supplies Manufacturing Association, Theatre Equipment Dealers Association, Annual Convention and Trade Show, Nov. 6–9, Morrison Hotel, Chicago.
American Rocket Society, Nov. 13–18, Chicago.
National Electrical Manufacturers Association, Annual Meeting, Nov. 14–18, Traymore Hotel, Atlantic City, N.J.
American Society of Mechanical Engineers, National Meeting, Nov. 13–18, Hotels Congress, Hilton and Blackstone, Chicago.
American Institute of Chemical Engineers, Nov. 27–30, Hotel Statler, Detroit.
Acoustical Society of America, Dec. 15–17, Brown U., Providence, R.I.
American Institute of Electrical Engineers, Winter General Meeting, Jan. 30–Feb. 3, 1956, Hotel Statler, New York.
Optical Society of America, Apr. 5–7, 1956, Bellevue-Stratford, Philadelphia, Pa.
79th Semiannual Convention of the SMPTE, including Equipment Exhibit, Apr. 29–May 4, 1956, Hotel Statler, New York.
80th Semiannual Convention of the SMPTE, Oct. 7–12, 1956, Ambassador Hotel, Los Angeles.
Optical Society of America, Oct. 18–20, 1956, Lake Placid Club, Essex Co., N.Y.
Optical Society of America, Mar. 7–9, 1957, Hotel Statler, New York.
81st Semiannual Convention of the SMPTE, Apr. 28–May 3, 1957, Shoreham Hotel, Washington, D.C.
82nd Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 6–11, 1957, Hotel Statler, New York.
83d Semiannual Convention of the SMPTE, April 20–26, 1958, Ambassador Hotel, Los Angeles.
84th Semiannual Convention of the SMPTE, Oct. 19–24, 1958, Sheraton-Cadillac, Detroit.
85th Semiannual Convention of the SMPTE, May 3–8, 1959, Fontainebleau, Miami Beach, Fla.
86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 5–10, 1959, Hotel Statler, New York.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April Journal.

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